Project Manual

Bid Package No. 3

Volume 2 of 2
(Divisions 21 thru 33)

Saint Luke's East Hospital

Flex Capacity Expansion

100 NE St. Luke's Blvd.
Lee's Summit, MO 64086

ARCHITECT: ACI / Boland, Inc.
1710 Wyandotte Street
Kansas City, MO 64108

CIVIL ENGINEER: McClure Engineering
1700 Swift Avenue, Suite 100
North Kansas City, MO 64116

STRUCTURAL ENGINEER: Structural Engineering Associates
1000 Walnut, Suite 1570
Kansas City, MO 64106

MEPF ENGINEER: W.L. Castle & Associates, Inc. | now IMEG
1600 Baltimore, Suite 300
Kansas City, MO 64108

ACIB Project No. 3-19092.00

March 30, 2020

RELEASE FOR CONSTRUCTION
AS NOTED ON PLANS REVIEW
DEVELOPMENT SERVICES
LEE'S SUMMIT, MISSOURI

Joe Frogge
Digitally signed by Joe Frogge
Reason: release for construction
Date: 2020.05.13 10:54:40-05'00'
05/13/2020

ACI BOLAND ARCHITECTS

PROJECT MANUAL

Bid Package No. 3

Saint Luke's East Hospital
Flex Capacity Expansion

Architect

ACI / BOLAND, INC.
1710 Wyandotte St
Kansas City, Missouri 64108
(816) 763-9600

Consulting Civil Engineer & Landscape Architect

McCLURE ENGINEERING
1700 Swift Avenue, Suite 100
North Kansas City, Missouri 64116
P: (816) 756-0444

Consulting Structural Engineer

STRUCTURAL ENGINEERING ASSOCIATES
1000 Walnut, Suite 1570
Kansas City, Missouri 64106
P: (816) 421-1042

Consulting MEPF Engineer

W. L. CASSELL & ASSOCIATES, INC. | now IMEG
1600 Baltimore, Suite 300
Kansas City, MO 64108
P: 816-842-8437

Specification Date

March 30, 2020

ACIB PROJECT NO. 3-19092.00

DISCLAIMER OF RESPONSIBILITY - ARCHITECT

I hereby state that all documents intended to be authenticated by my seal are limited to:

A. PROJECT MANUAL:

DIVISION 00	DIVISION 02	DIVISION 03	DIVISION 04	DIVISION 05
DIVISION 06	DIVISION 07	DIVISION 08	DIVISION 09	DIVISION 10
DIVISION 12	DIVISION 01			

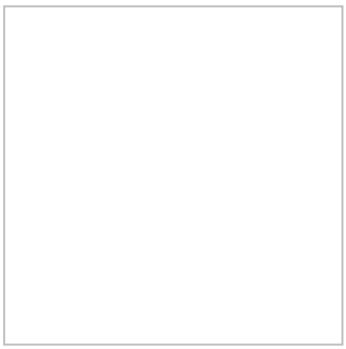
NOTE: Divisions listed include all sections listed in Table of Contents for that Division.

B. DRAWINGS:

A0.1	A0.2	A0.3	A0.4	A0.5	A0.6
A2.1	A2.2	A2.3	A2.4	A2.5	A2.6
A2.7	A2.8	A2.9	A2.10	A2.11	A2.12
A3.1	A3.2	A3.3	A4.1	A4.2	A5.1
A5.2	A5.3	A6.1	A6.2	A6.3	A6.4
A6.5	A6.6	A6.7	A6.8	A6.9	A6.10
A6.11	A6.12	A6.13	A7.1	A7.2	A7.3
A7.4	A7.5	A7.6	A2.13	AD2.1	

I hereby disclaim any responsibility for all other specifications, estimates, reports or other documents or instruments related to or intended to be used for any part or parts of this architectural project.

SEAL:



Name: Samuel K. Beckman
Registration No.: Missouri / #A-2011012130
Discipline: Architect
Title: Principal
Company Name: ACI Boland Architects

DISCLAIMER OF RESPONSIBILITY - MECHANICAL

I hereby state that all documents intended to be authenticated by my seal are limited to:

A. PROJECT MANUAL:

Division 23				

NOTE: Divisions listed include all sections listed in Table of Contents for that division.

B. DRAWINGS:

DMG1	MG1.	MG1.2	DM1	DMP1
DM2	M1.1	M1.2	MP1.1	MP1.2
MP1.3	M2.1	M2.2	M3.1	M3.2
M4.0	M5.0	M6.0		

I hereby disclaim any responsibility for all other specifications, estimates, reports or other documents or instruments related to or intended to be used for any part or parts of this architectural project.

SEAL:

Name: Bruce E. Hart
State / Registration No.: Missouri E-22817
Discipline: Mechanical Engineering
Title: Principal
Company Name: W. L. Cassell & Associates, Inc.

DISCLAIMER OF RESPONSIBILITY - ELECTRICAL

I hereby state that all documents intended to be authenticated by my seal are limited to:

A. PROJECT MANUAL:

Division 26	Division 27	Division 28		

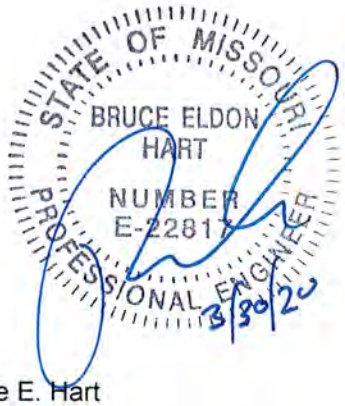
NOTE: Divisions listed include all sections listed in Table of Contents for that division.

B. DRAWINGS:

E000	DEL1.1	DEP1.1	DEC1.1	DE2.1
EL1.1	EL1.2	EP1.1	EP1.2	EC1.1
EC1.2	E2.0	E2.1	E2.2	E3.1
E3.2	E4.0	E4.1	E5.0	E5.1
E6.0				

I hereby disclaim any responsibility for all other specifications, estimates, reports or other documents or instruments related to or intended to be used for any part or parts of this architectural project.

SEAL:



Name: Bruce E. Hart
State / Registration No.: Missouri E-22817
Discipline: Electrical Engineering
Title: Principal
Company Name: W. L. Cassell & Associates, Inc.

DISCLAIMER OF RESPONSIBILITY – PLUMBING & FIRE PROTECTION

I hereby state that all documents intended to be authenticated by my seal are limited to:

A. PROJECT MANUAL:

Division 21	Division 22			

NOTE: Divisions listed include all sections listed in Table of Contents for that division.

B. DRAWINGS:

PM000	PME100	DP1	DP2	P0.1
P0.2	P1.1	P1.2	P2.1	P2.2
P3.1	P4.0			

I hereby disclaim any responsibility for all other specifications, estimates, reports or other documents or instruments related to or intended to be used for any part or parts of this architectural project.

SEAL:

Name: Bruce E. Hart
State / Registration No.: Missouri E-22817
Discipline: Plumbing Engineering
Title: Principal
Company Name: W. L. Cassell & Associates, Inc.

SECTION 00 01 10
TABLE OF CONTENTS

END OF SECTION

SECTION 00 01 15
LIST OF DRAWINGS

GENERAL DRAWINGS:

A0.0	A0.1	A0.2	A0.3	A0.4	A0.5
A0.6					

CIVIL DRAWINGS: Refer to Bid Package No. 2

NONE					

DEMOLITION DRAWINGS:

AD2.1					

ARCHITECTURAL DRAWINGS:

A2.1	A2.2	A2.3	A2.4	A2.5	A2.6
A2.7	A2.8	A2.9	A2.10	A2.11	A2.12
A3.1	A3.2	A3.3	A4.1	A4.2	A5.1
A5.2	A5.3	A6.1	A6.2	A6.3	A6.4
A6.5	A6.6	A6.7	A6.8	A6.9	A6.10
A6.11	A6.12	A6.13	A7.1	A7.2	A7.3
A7.4	A7.5	A7.6	A2.13		

STRUCTURAL DRAWINGS: Refer to Bid Package No. 2

NONE					

PLUMBING DRAWINGS:

DP1	DP2	P0.1	P0.2	P1.1	P1.2
P2.1	P2.2	P3.1	P4.0	DMG1	MG1.1
MG1.2					

MECHANICAL DRAWINGS:

DM1	DMP1	DM2	M1.1	M1.2	MP1.1
MP1.2	MP1.3	M2.1	M2.2	M3.1	M3.2
M4.0	M5.0	M6.0			

ELECTRICAL DRAWINGS:

E000	DEL1	DEP1	DEC1	EL1.1	EL1.2
EP1.1	EP1.2	EC1.1	EC1.2	E2.0	E2.1
E2.3	E3.1	E3.2			

END OF SECTION

SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Coordination drawings.
7. Project record drawings.
8. TMS Asset Forms
9. Trenching, excavating and backfilling.
10. Fire-suppression equipment and piping demolition.
11. Equipment installation requirements common to equipment sections.
12. Painting and finishing.
13. Concrete bases.
14. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.
2. Escutcheons.

1.5 QUALITY ASSURANCE

A. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Any additional costs as a results of these modifications shall be borne by the contractor. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Sequence, coordinate, and integrate installations of fire suppression materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of fire suppression systems with exterior underground and overhead utilities and service. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Sequence, coordinate, and integrate removal of existing equipment and material as required to maintain services for existing building and for portions of remodeled areas at all times.

1.8 SCHEDULING AND PHASING

A. All fire suppression work shall be scheduled to meet project completion data. Fire suppression work shall be phased for projects requiring phasing of work. Install additional fittings, valves, caps as required to support phasing. Refer to phasing schedule on drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Acceptable Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM or NBR 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. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

C. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

E. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.8 COORDINATION DRAWINGS

A. The Contractor shall prepare CAD generated drawings (min. ¼" scale) showing following systems/items as a minimum:

1. Fire suppression piping routing including locations of valves, drops to sprinkler heads, risers, etc.
2. Fire suppression equipment locations and clearances required.

B. The Contractor shall submit the CAD generated drawings to HVAC contractor for coordination with other trades. The drawings shall be submitted either in electronic format or printed copies as requested by HVAC Contractor.

C. The Contractor shall participate in coordination meetings when requested by HVAC Contractor.

D. See General Conditions for additional coordination drawing requirements

2.9 PROJECT RECORD DRAWINGS

A. See General Conditions for project record drawings requirements.

2.10 TMS ASSET FORMS

A. The Contractor shall populate and update Owner's TMS Asset forms for all areas renovated. This shall include listing information for all new equipment installed, existing equipment that is reused and deleting equipment removed during construction.

PART 3 - EXECUTION

3.1 TRENCHING, EXCAVATING AND BACKFILLING

A. Excavate to required dimensions and depth. The trench excavation shall be in open cut from surface and shall be minimum width necessary to permit the placing of the pipe as required. Excess excavation shall be backfilled with crusher run rock. Such rocks shall be placed at the Contractor's expense. Lines shall be used to lay out trenches.

B. All excavations shall be properly protected by the necessary bracing and timbers, to prevent any cave-ins or injury to adjacent improvements. The sides of the excavations shall be securely held by bracing or sheathing, which bracing or sheathing shall not be removed until the level of the backfill has reached the point where such removal can be safely carried out. Where adjacent improvements might be injured by the removal of such bracing, the braces shall be left in place to prevent such injury. The thickness of the sheathing and dimensions of the brass braces, shoes and miscellaneous supports to be used by the Contractor shall be of the type required to properly protect the sides of the trench and to prevent injurious cave-ins or erosions.

C. The Contractor shall do all pumping and bailing necessary to keep all excavations free of water and shall provide for the uninterrupted flow of the surface water adjacent to the line of the work during the progress of the work. The Contractor shall inspect the ground where excavation is required to ascertain the structure of the soil. Additional consideration will not be allowed for encountering rock, stone, old foundations or other unfavorable excavating conditions.

D. The Contractor shall replace all existing walks, roads, street pavements, curbs, retaining walls, steps and miscellaneous work removed or damaged in connection with the utility service installation, whether or not the improvement is shown on the drawings. Such repairs shall be done to the satisfaction of the Architect. All street cuts shall be repaired in a manner meeting the approval of the Owner.

E. In cases where existing water, sewer, electric, steam or other pipes are encountered, they shall not be displaced or disturbed unless necessary, in which case they shall promptly be replaced in good condition. All water, sewer, steam or electric lines damaged or disturbed in the construction shall be replaced or repaired at the Contractor's expense, unless, in the option of the Architect, such damage was caused through no fault of the Contractor.

F. Contractor shall provide all temporary bridges, steel plates, barricades, lanterns, and such other signs and signals by day as shall be necessary to warn the public of and protect the public from the dangers caused by excavations and other obstructions, day and night.

G. The backfilling of trenches shall be carried out as rapidly as the testing and acceptance of the finished sections of the installation will permit. The trench shall be backfilled in layers of not to exceed eight inches (8") with good selected clean earth, thoroughly tamped with mechanical tamper to a 95% optimum compaction. Density shall be tested by an approved laboratory, using a standard method. Tests shall be made for each 2 ft. depth on the basis of one test per 1000 sq. ft. of fill area. Last 12" of backfill (except under streets, drives, and walks) shall be made with good clean top soil. Contractor shall obtain and pay for tests. Submit five (5) copies of tests for approval. Note: Broken stones, cinders, wood and rubbish are not acceptable for backfilling. Backfill all street cuts in a manner meeting the approval of the Architect.

H. In spaces between walls and line of excavation, fill with thin layers of selected clean earth; thoroughly tamp in eight inches (8") thick layers and bring up to a finished level of established grades. All wood and foreign materials shall be removed from excavation prior to backfilling.

I. After backfilling, all surplus excavated materials shall be removed from the property.

J. The work shall be executed so that existing culverts, walks, retaining walls, steps, fences or any permanent structure along and adjacent to the new work are properly protected. Any damage occurring to these structures shall be repaired by the Contractor at his own expense.

K. The Contractor shall make a field inspection of the location along which the underground piping is to be constructed, and note all obstructions and improvements at the surface and overhead which may affect the method of operation in the construction of these lines. Such overhead

wires and underground pipes or conduits which may exist, or which may be encountered, shall be protected by the Contractor during this construction. Any expense or inconvenience caused by their existence and the necessary protection for utilities adjacent thereto shall be considered as covered and included in the contract, without additional cost to the Owner.

3.2 FIRE-SUPPRESSION DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Generally remove piping up to existing mains or valves.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping minimum 8 inches above accessible ceilings to allow sufficient space for ceiling panel removal and service access.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, stamped-steel type with polished chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw or spring clips.
f. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
d. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
e. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
f. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

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

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" and General Conditions for additional requirements.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

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

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

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 21 05 48

VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Restraining braces.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
2. Seismic-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in this Section are more stringent.

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

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall be pre-approved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Pads Type A.1: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Mounts Type A.2: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators Type B.1: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to ¼-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Elastomeric Hangers Type B.4: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

F. Pipe Riser Resilient Support Type D.1: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of ½-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

G. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of ½-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Steel Base Type E.1: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base Type E.2: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. Cooper B-Line, Inc.; a division of Cooper Industries.
3. Hilti, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

I. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127 and NFPA 13.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 VIBRATION ISOLATOR AND SEISMIC-RESTRAINT SCHEDULE FOR SLAB ON GRADE LOCATED EQUIPMENT

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Fire Pumps	Floor	All sizes	E.1	A.2	0.25”
Piping – Horizontal	Suspended	All sizes	--	B.4	0.25”
Piping – Vertical	Floor	All sizes	--	D.1	0.25”

Notes:
1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.
2. Isolators indicated for horizontal piping is only for three (3) hangers on discharge/outlet and three (3) hangers on suction/inlet pipes for pumps, air compressors, vacuum pumps, and equipment mounted on type “B” isolators. Remaining piping does not require isolation.

3.5 VIBRATION ISOLATOR AND SEISMIC – RESTRAINT SCHEDULE FOR EQUIPMENT LOCATED ABOVE GRADE

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Fire Pumps	Floor	All sizes	E.2	B.1	1”
Piping – Horizontal	Suspended	All sizes	--	B.4	0.25”
Piping – Vertical	Floor	All sizes	--	D.1	0.25”

Notes:
1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.
2. Isolators indicated for horizontal piping is only for three (3) hangers on discharge/outlet and three (3) hangers on suction/inlet pipes for pumps, air compressors, vacuum pumps, and equipment mounted on type “B” isolators. Remaining piping does not require isolation.

END OF SECTION

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Excess-pressure pumps.
6. Alarm devices.
7. Manual control stations.
8. Control panels.
9. Pressure gages.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Standpipes" for standpipe piping.
2. Division 21 Section "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTIONS

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

1.5 PERFORMANCE REQUIREMENTS

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

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

1. Contractor shall obtain fire-hydrant flow test records from authorities having jurisdiction.

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

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications According to NFPA 13 Unless Otherwise Noted:

a. Automobile Parking Areas: Ordinary Hazard, Group 1.
b. Building Service Areas: Ordinary Hazard, Group 1.
c. Churches: Light Hazard.
d. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
e. General Storage Areas: Ordinary Hazard, Group 1.
f. Libraries except Stack Areas: Light Hazard.
g. Library Stack Areas: Ordinary Hazard, Group 2.
h. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
i. Office and Public Areas: Light Hazard.
j. Repair Garages: Ordinary Hazard, Group 2.
k. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design According to NFPA 13 Unless Noted Otherwise:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

4. Minimum Density for Deluge-Sprinkler Piping Design:

a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.
b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over entire area.
c. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over entire area.
d. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over entire area.
e. Special Occupancy Hazard: As determined by authorities having jurisdiction.

5. Maximum Protection Area per Sprinkler According to NFPA 13 Unless Noted Otherwise:

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

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

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

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

1.6 SUBMITTALS

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

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

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

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

D. Coordination Drawings: Sprinkler systems, drawn to minimum ¼" scale, on CAD generated drawings. Refer to Section "Common Work Results for Fire Suppression".

E. Qualification Data: For qualified Installer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

G. Fire-hydrant flow test report.

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

I. Field quality-control reports.

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

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

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

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

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

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

1.8 PROJECT CONDITIONS

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

1. Notify Owner no fewer than ten days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Owner's written permission.
3. Contractor shall coordinate interruption of service with Owner on a daily basis.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies. Refer to Section “Common Work Results for Fire Suppression” for details.

1.10 EXTRA MATERIALS

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

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

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

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

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

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

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

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

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

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

I. Grooved-Joint, Steel-Pipe Appurtenances:

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

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

2. Pressure Rating: 175 psig minimum.
3. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

J. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.

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

1. Anvil International, Inc.
2. Clow Valve Company; a division of McWane, Inc.
3. Crane Co.; Crane Valve Group; Crane Valves.
4. Fire Protection Products, Inc.
5. Globe Fire Sprinkler Corporation.
6. Kennedy Valve; a division of McWane, Inc.
7. Metraflex, Inc.
8. Milwaukee Valve Company.
9. Mueller Co.; Water Products Division.
10. NIBCO INC.
11. Potter Roemer.
12. Reliable Automatic Sprinkler Co., Inc.
13. Tyco Fire & Building Products LP.
14. Victaulic Company.
15. Viking Corporation.
16. Watts Water Technologies, Inc.

C. Ball Valves:

1. Standard: UL 1091 except with ball instead of disc.
2. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
3. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
4. Valves NPS 3: Ductile-iron body with grooved ends.

D. Bronze Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig.
3. Body Material: Bronze.
4. End Connections: Threaded.

E. Iron Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Style: Lug or wafer.
5. End Connections: Grooved.

F. Check Valves:

1. Standard: UL 312.
2. Pressure Rating: 250 psig minimum.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

G. Bronze OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig.
3. Body Material: Bronze.
4. End Connections: Threaded.

H. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

I. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valves NPS 2 and Smaller:

    a. Valve Type: Ball or butterfly.
    b. Body Material: Bronze.
    c. End Connections: Threaded.

4. Valves NPS 2-1/2 and Larger:

    a. Valve Type: Butterfly.
    b. Body Material: Cast or ductile iron.
    c. End Connections: Flanged, grooved, or wafer.

5. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch visual indicating device.

J. NRS Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Cast iron with indicator post flange.
4. Stem: Nonrising.
5. End Connections: Flanged or grooved.

2.5 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:

    a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.

5. End Connections: Flanged or grooved.

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

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

C. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.6 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.7 Sprinklers

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

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

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Type: All sprinklers shall be quick response type.
3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

1. Characteristics:

a. Nominal 1/2-inch Orifice: With Discharge Coefficient K between 5.3 and 5.8.

E. Sprinkler Finishes:

1. Chrome plated.

2. Bronze.
3. Painted.

F. Special Coatings:

1. Wax.
2. Lead.
3. Corrosion-resistant paint.

G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

H. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.8 Alarm Devices

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

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

a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Notifier; a Honeywell company.
c. Potter Electric Signal Company.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:

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

a. ADT Security Services, Inc.
b. McDonnell & Miller; ITT Industries.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
e. Viking Corporation.
f. Watts Industries (Canada) Inc.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.

4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

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

    a. Detroit Switch, Inc.
    b. Potter Electric Signal Company.
    c. System Sensor; a Honeywell company.
    d. Tyco Fire & Building Products LP.
    e. United Electric Controls Co.
    f. Viking Corporation.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

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

    a. Fire-Lite Alarms, Inc.; a Honeywell company.
    b. Kennedy Valve; a division of McWane, Inc.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

F. Indicator-Post Supervisory Switches:

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

    a. Potter Electric Signal Company.
    b. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.9 Pressure Gages

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

1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" and “DATE” label on dial face.

2.10 Escutcheons

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with set-screws.

C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.

E. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with concealed hinge and set-screw.

F. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed hinge, set-screw or spring clips.

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

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

2.11 Sleeves

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

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

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set-screws.

2.12 Sleeve Seals

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.13 Grout

A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 Preparation

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

B. Report test results promptly and in writing.

3.2 Water-Supply Connections

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Division 22 Section "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.3 Piping Installation

A. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

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

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

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

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

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices.

N. Fill sprinkler system piping with water.

O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

3.4 Joint Construction

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

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

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

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

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

G. 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.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

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

J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

L. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

M. 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.

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

3.5 Valve and Specialties Installation

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.6 Sprinkler Installation

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.7 Escutcheon Installation

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

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with rough-brass finish or stamped steel with set-screw or spring clips.
5. Bare Piping in Equipment Rooms: One piece, cast brass stamped steel with set-screw or spring clips.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:

1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.

3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split casting, cast brass rough-brass finish plate, stamped steel with concealed hinge and set-screw or spring clips.
6. Bare Piping in Equipment Rooms: Split casting, cast brass plate, stamped steel with set-screw or spring clips.
7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.8 Sleeve Installation

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE or Galvanized-steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:

a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
b. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.
c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.

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

3.9 Sleeve Seal Installation

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 Identification

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

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Install self-adhesive, preprinted vinyl labels on ceiling grid to identify location of fire sprinkler valves and miscellaneous equipment above. All fire sprinkler system labels shall be red in color with black lettering matching the Owner’s standards.

3.11 Field Quality Control

A. Perform tests and inspections.

B. Tests and Inspections:

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

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

D. Prepare test and inspection reports.

3.12 Cleaning

A. Clean dirt and debris from sprinklers.

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

3.13 Demonstration

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.14 Piping Schedule

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded or grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.

C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.

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

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
3. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:

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

3.15 Sprinkler Schedule

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

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
5. Special Applications: Extended-coverage, flow-control, sprinklers where indicated.

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

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Coordination drawings.
9. Project record drawings.
10. TMS Asset Forms
11. Trenchings, excavating and backfilling.
12. Plumbing demolition.
13. Equipment installation requirements common to equipment sections.
14. Painting and finishing.
15. Concrete bases.
16. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Any additional costs as a result of these modifications shall be borne by the Contractor. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

D. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Sequence, coordinate, and integrate removal of existing equipment and material as required to maintain services for existing building and for portions of remodeled areas at all times.

1.8 SCHEDULING AND PHASING

A. All plumbing work shall be scheduled to meet project completion date. Plumbing work shall be phased for projects requiring phasing of work. Install additional fittings, valves, caps as required to support phasing. Refer to phasing schedule on drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

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

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. Acceptable Manufacturers:

1. Cascade Waterworks Mfg. Co.
2. Dresser Industries, Inc.; DMD Div.
3. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
4. JCM Industries.
5. Smith-Blair, Inc.
6. Viking Johnson.

B. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
3. Aboveground Pressure Piping: Pipe fitting.

C. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

D. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

E. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Acceptable Manufacturers:

1. Capitol Manufacturing Co.
2. Calpico, Inc.
3. Epco Sales, Inc.
4. Hart Industries, International, Inc.
5. Lochinvar Corp.;
6. Watts Industries, Inc.; Water Products Div.
7. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Acceptable Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM or NBR 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. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated or rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.10 COORDINATION DRAWINGS

A. The contractor shall prepare CAD generated drawings (min. ¼" scale) showing following systems/items as a minimum:

1. Plumbing piping routing including locations of valves, drops to fixtures, risers, etc.
2. Plumbing equipment locations and clearances required.
3. Medical gas piping routing including locations of zone valves, area valves, drops to outlets, risers, etc.
4. Medical gas equipment locations and clearances required.

B. The contractor shall submit the CAD generated drawings to mechanical contractor for coordination with other trades. The drawings shall be submitted either in electronic format or printed copies as requested by HVAC Contractor.

C. The contractor shall participate in coordination meetings when requested by HVAC Contractor.

D. See General Conditions for project coordination drawing requirements.

2.11 PROJECT RECORD DRAWINGS

A. See General Conditions for project record drawings requirements.

2.12 TMS ASSET FORMS

A. The Contractor shall populate and update Owner's TMS Asset forms for all areas renovated. This shall include listing information for all new equipment installed, existing equipment that is reused and deleting equipment removed during construction.

PART 3 - EXECUTION

3.1 TRENCHING, EXCAVATING AND BACKFILLING

A. Excavate to required dimensions and depth. The trench excavation shall be in open cut from surface and shall be minimum width necessary to permit the placing of the pipe as required. Excess excavation shall be backfilled with crusher run rock. Such rocks shall be placed at the Contractor's expense. Lines shall be used to lay out trenches.

B. All excavations shall be properly protected by the necessary bracing and timbers, to prevent any cave-ins or injury to adjacent improvements. The sides of the excavations shall be securely held by bracing or sheathing, which bracing or sheathing shall not be removed until the level of the backfill has reached the point where such removal can be safely carried out. Where adjacent improvements might be injured by the removal of such bracing, the braces shall be left in place to prevent such injury. The thickness of the sheathing and dimensions of the brass braces, shoes and miscellaneous supports to be used by the Contractor shall be of the type required to properly protect the sides of the trench and to prevent injurious cave-ins or erosions.

C. The Contractor shall do all pumping and bailing necessary to keep all excavations free of water and shall provide for the uninterrupted flow of the surface water adjacent to the line of the work during the progress of the work. The Contractor shall inspect the ground where excavation is required to ascertain the structure of the soil. Additional consideration will not be allowed for encountering rock, stone, old foundations or other unfavorable excavating conditions.

D. The Contractor shall replace all existing walks, roads, street pavements, curbs, retaining walls, steps and miscellaneous work removed or damaged in connection with the utility service installation, whether or not the improvement is shown on the drawings. Such repairs shall be done to the satisfaction of the Architect. All street cuts shall be repaired in a manner meeting the approval of the Owner.

E. In cases where existing water, sewer, electric, steam or other pipes are encountered, they shall not be displaced or disturbed unless necessary, in which case they shall promptly be replaced in good condition. All water, sewer, steam or electric lines damaged or disturbed in the construction shall be replaced or repaired at the Contractor's expense, unless, in the opinion of the Architect, such damage was caused through no fault of the Contractor.

F. Contractor shall provide all temporary bridges, steel plates, barricades, lanterns, and such other signs and signals by day as shall be necessary to warn the public of and protect the public from the dangers caused by excavations and other obstructions, day and night.

G. The backfilling of trenches shall be carried out as rapidly as the testing and acceptance of the finished sections of the installation will permit. The trench shall be backfilled in layers of not to exceed eight inches (8") with good selected clean earth, thoroughly tamped with mechanical tamper to a 95% optimum compaction. Density shall be tested by an approved laboratory, using a standard method. Tests shall be made for each 2 ft. depth on the basis of one test per 1000 sq. ft. of fill area. Last 12" of backfill (except under streets, drives, and walks) shall be made with good clean top soil. Contractor shall obtain and pay for tests. Submit five (5) copies of tests for approval. Note: Broken stones, cinders, wood and rubbish are not acceptable for backfilling. Backfill all street cuts in a manner meeting the approval of the Architect.

H. In spaces between walls and line of excavation, fill with thin layers of selected clean earth; thoroughly tamp in eight inches (8") thick layers and bring up to a finished level of established grades. All wood and foreign materials shall be removed from excavation prior to backfilling.

I. After backfilling, all surplus excavated materials shall be removed from the property.

J. The work shall be executed so that existing culverts, walks, retaining walls, steps, fences or any permanent structure along and adjacent to the new work are properly protected. Any damage occurring to these structures shall be repaired by the Contractor at his own expense.

K. The Contractor shall make a field inspection of the location along which the underground piping is to be constructed, and note all obstructions and improvements at the surface and overhead which may affect the method of operation in the construction of these lines. Such overhead wires and underground pipes or conduits which may exist, or which may be encountered, shall be protected by the Contractor during this construction. Any expense or inconvenience caused by their existence and the necessary protection for utilities adjacent thereto shall be considered as covered and included in the contract, without additional cost to the Owner.

3.2 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to be Removed: Removed portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Generally remove piping up to existing mains or valves.
2. Piping to be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Cap behind walls, chases, or shafts or flush with floor. Patch surfaces to match existing adjacent surfaces.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment from project site.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping minimum 8 inches above accessible ceilings to allow sufficient space for ceiling panel removal and service access. In general install piping tight to slab, beams, joists and structural members if possible.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

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

2. Existing Piping: Use the following:

   a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
   e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
   f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

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

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

V. Draining and Refilling of Systems: Provide all shutoff valves, drain valves, pipe, fittings, and miscellaneous material required to drain each existing system as required for new work. After new work is completed, tested, and found tight, refill each system as required. Time for shutting down existing system for draining shall be coordinated with all other work and with Owner's representative. Cost for all chemicals and additives for refill shall be borne by the Contractor.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 Piping Connections

A. 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. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.6 Equipment Installation - Common Requirements

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.7 Painting

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 Concrete Bases

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete".

3.9 Erection of Metal Supports and Anchorages

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.10 Grouting

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

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

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

2.2 MOTOR CHARACTERISTICS

A. Motors ½ HP and Larger: Three phase, unless shown otherwise.

B. Motors Smaller than ½ HP: Single phase, unless shown otherwise.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

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

H. Enclosure: Open dripproof.

2.3 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

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

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F unless otherwise noted.

I. Code Letter Designation:

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

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

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

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Motors under 100 hp – Provide shaft grounding ring on either the drive end or non-drive end of the motor in accordance with manufacturer's recommendations.
6. Motors 100 hp and above – Provide ceramic bearing or bearing journal on non-drive end of the motor and shaft grounding ring on the opposite end in accordance with manufacturer's recommendations.

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

2.5 SINGLE-PHASE MOTORS

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

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

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

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

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

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron, center-guided check valves.
7. Bronze globe valves.
8. Chainwheels.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

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 angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block 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. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every ten (10) plug valves, for each size square plug-valve head.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

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

1. Crane Co., Crane Valve Group
2. Hammond Valve.
3. Milwaukee Valve Company.
4. NIBCO Inc.

B. Class 150, Bronze Angle Valves with Bronze Disc:

1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron.

2.3 BRONZE BALL VALVES

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

1. American Valve, Inc.
2. Conbraco Industries, Inc.; Apollo Valves.
3. Crane Co.; Crane Valve Group; Crane Valves.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

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

1. Conbraco Industries, Inc.; Apollo Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. DeZurik Water Controls.
5. Hammond Valve.
6. Milwaukee Valve Company.
7. NIBCO INC.
8. Spence Strainers International; a division of CIRCOR International, Inc.
9. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Description:

    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    e. Seat: EPDM.
    f. Stem: One- or two-piece stainless steel.
    g. Disc: Nickel-plated or -coated ductile iron.

2.5 BRONZE SWING CHECK VALVES

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

1. American Valve, Inc.
2. Crane Co.; Crane Valve Group; Crane Valves.
3. Crane Co.; Crane Valve Group; Jenkins Valves.
4. Crane Co.; Crane Valve Group; Stockham Division.
5. Hammond Valve.
6. Milwaukee Valve Company.
7. NIBCO Inc.
8. Powell Valves.
9. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. 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.
    f. Disc: Bronze.

2.6 IRON SWING CHECK VALVES

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

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO Inc.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Iron Swing Check Valves with Metal Seats:

1. 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.
    f. Trim: Bronze.
    g. Gasket: Asbestos free.

C. Class 250, Iron Swing Check Valves with Metal Seats:

1. 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.
    f. Trim: Bronze.
    g. Gasket: Asbestos free.

2.7 IRON, CENTER-GUIDED CHECK VALVES

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

1. Anvil International, Inc.
2. Hammond Valve.
3. Metraflex, Inc.
4. Milwaukee Valve Company.
5. Mueller Steam Specialty; a division of SPX Corporation.
6. NIBCO INC.
7. Spence Strainers International; a division of CIRCOR International, Inc.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

1. 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: Compact wafer.
    e. Seat: Bronze.

C. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. 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: Compact wafer.
e. Seat: EPDM or NBR.

2.8 BRONZE GLOBE VALVES

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

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Stockham Division.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO Inc.
6. Powell Valves.
7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Bronze Globe Valves with Bronze Disc:

1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron.

C. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

D. Class 150, Bronze Globe Valves with Nonmetallic Disc:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.9 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for valves 6 inches and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly**,** gate, or plug valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Globe or angle, ball, or butterfly valves.
4. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat 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. Pressure ratings for valves shall not be less than as required by system pressures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

D. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 and Larger: Flanged ends.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze disc.
3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.

2. Iron Swing Check Valves: Class 150 or Class 250, metal seats.
3. Iron, Center-Guided Check Valves: Class 150, compact-wafer, metal or resilient seat.
4. Iron Globe Valves: Class 150 or Class 250.

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. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

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

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.
5. Pipe positioning systems.

B. Welding certificates.

1.6 QUALITY ASSURANCE

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

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Acceptable Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. Empire Industries, Inc.
4. Globe Pipe Hanger Products, Inc.
5. Grinnell Corp.
6. GS Metals Corp.
7. National Pipe Hanger Corporation.
8. Piping Technology & Products, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of polyurethane or stainless steel.

1. Acceptable Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Champion Fiberglass, Inc.
c. Cope, T. J., Inc.; Tyco International, Ltd.
d. Unistrut Corp.; Tyco International, Ltd.

B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.

1. Acceptable Manufacturers:

a. Plasti-Fab, Inc.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Acceptable Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. GS Metals Corp.
3. Power-Strut Div.; Tyco International, Ltd.

4. Thomas & Betts Corporation.
5. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

B. Acceptable Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Champion Fiberglass, Inc.
3. Cope, T. J., Inc.; Tyco International Ltd.

2.7 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Acceptable Manufacturers:

1. Carpenter & Paterson, Inc.
2. PHS Industries, Inc.
3. Pipe Shields, Inc.
4. Rilco Manufacturing Company, Inc.
5. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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

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

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

2.8 FASTENER SYSTEMS

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

1. Acceptable Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.

2.9 PIPE STAND FABRICATION

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

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Base: Plastic or Stainless steel.
2. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
3. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Bases: One or more plastic.
2. Vertical Members: Two or more protective-coated-steel channels.
3. Horizontal Member: Protective-coated-steel channel.
4. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.10 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

2.11 EQUIPMENT SUPPORTS

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

2.12 MISCELLANEOUS MATERIALS

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

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

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

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

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

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

F. 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 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, 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 or insulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or 2-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.
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 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 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
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 might occur and vertical adjustment is not necessary.
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 might be required in addition to expansion and contraction.

G. 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 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. 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.

J. 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.

K. 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 absorb 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 absorb 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 absorb 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.

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

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

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

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

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

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. 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. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

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

G. Fastener System Installation:

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

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

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

I. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

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

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

L. 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.

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

N. 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.

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

P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

Q. Insulated Piping: Comply with the following:

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 according to 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: 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 inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation 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 smooth bearing surface.

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

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

END OF SECTION

SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS 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. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Freestanding spring isolators.
4. Elastomeric hangers.
5. Spring hangers.
6. Pipe riser resilient supports.
7. Resilient pipe guides.
8. Seismic snubbers.
9. Restraining braces and cables.
10. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

C. Coordination Drawings: Show coordination of seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall be preapproved by agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Pads Type A.1: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Mounts Type A.2: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators Type B.1: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Elastomeric Hangers Type B.4: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

F. Spring Hangers Type B.5: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. Pipe Riser Resilient Support Type D.1: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

H. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Steel Base Type E.1: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base Type E.2: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. Cooper B-Line, Inc.; a division of Cooper Industries.
3. Hilti, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four (4) times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.
3. Install seismic-restraint devices using methods approved by authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of sprint isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 VIBRATION ISOLATOR AND SEISMIC-RESTRAINT SCHEDULE FOR SLAB ON GRADE LOCATED EQUIPMENT

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Hot Water Heaters (Vertical or Horizontal	Floor	All sizes	--	A.1	0.25”
Water Softening/RO System/ DI System Equipment	Floor	All sizes	--	A.1	0.25”
Centrifugal Pumps, Booster Pumps	Floor Floor Suspended	Up to 10 HP Above 10 HP All sizes	E.1 E.2 _	A.2 B.1 B.5	0.25” 0.75” 0.25”
Air Compressors	Floor	All sizes	E.1	B.1	1.0”
Vacuum Pumps	Floor	All sizes	E.1	B.1	1.0”
Piping – Horizontal	Suspended	All sizes	--	B.4	0.25”
Piping – Vertical	Floor	All sizes	--	D.1	0.25”

Notes:
1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.
2. Isolators indicated for horizontal piping is only for three (3) hangers on discharge/outlet and three (3) hangers on suction/inlet pipes for pumps, air compressors, vacuum pumps, and equipment mounted on type “B” isolators. Remaining piping does not require isolation.

3.7 VIBRATION ISOLATOR AND SEISMIC – RESTRAINT SCHEDULE FOR EQUIPMENT LOCATED ABOVE GRADE

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Hot Water Heaters (Vertical or Horizontal	Floor	All sizes	--	A.1	0.25”
Water Softening/RO System/ DI System Equipment	Floor	All sizes	--	A.1	0.25”
Centrifugal Pumps, Booster Pumps	Floor Suspended	All sizes All sizes	E.2 -	B.1 B.5	1” 0.25”
Air Compressors	Floor	All sizes	E.2	B.2	1.0”
Vacuum Pumps	Floor	All sizes	E.2	B.2	1.0”
Piping – Horizontal	Suspended	All sizes	--	B.4	0.25”
Piping – Vertical	Floor	All sizes	--	D.1	0.25”

Notes:
1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.
2. Isolators indicated for horizontal piping is only for three (3) hangers on discharge/outlet and three (3) hangers on suction/inlet pipes for pumps, air compressors, vacuum pumps, and equipment mounted on type “B” isolators. Remaining piping does not require isolation.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION 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. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.
7. Ceiling grid labels.

1.3 SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
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: 1/2 inch and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

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

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

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

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

F. Minimum Letter Size: 1/2 inch and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

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

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

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches.

2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

2.7 CEILING GRID LABELS

A. Self-Adhesive Vinyl Labels for valves and equipment: Minimum ½" Preprinted, flexible label to match Owner's standards. Color as directed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting".

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment and within mechanical rooms, boiler rooms, chiller rooms, etc.

7. On piping above removable acoustical ceilings.

D. Pipe Label Color Schedule:

1. Low-Pressure, Compressed-Air Piping:

a. Background Color: Yellow.
b. Letter Color: White.

2. Medium-Pressure, Compressed-Air Piping:

a. Background Color: Yellow.
b. Letter Color: White.

3. Domestic Water Piping:

a. Background Color: Blue.
b. Letter Color: White.

4. Sanitary Waste and Storm Drainage Piping:

a. Background Color: Black.
b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 1-1/2 inches, round.
b. Hot Water: 1-1/2 inches.
c. Low-Pressure Compressed Air: 1-1/2 inches.
d. High-Pressure Compressed Air: 1-1/2 inches.

2. Valve-Tag Color:

a. Cold Water: Natural.
b. Hot Water: Natural.
c. Low-Pressure Compressed Air: Natural.
d. High-Pressure Compressed Air: Natural.

3. Letter Color:

a. Cold Water: Black.
b. Hot Water: Black.
c. Low-Pressure Compressed Air: Black.

d. High-Pressure Compressed Air: Black.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.6 CEILING GRID LABELS

A. Install ceiling grid labels for all equipment located above ceilings such as domestic water valves, medical gas valves and miscellaneous equipment. Color of labels shall match owner's standards.

END OF SECTION

SECTION 22 07 00

PLUMBING 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:

1. Insulation Materials:

a. Cellular glass.
b. Flexible elastomeric.
c. Mineral fiber.
d. Molded Close Cell.

2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections include the following:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

1.4 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting 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 and inspecting agency.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment 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.

1.7 SCHEDULING

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

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 Part 3 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. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Cell-U-Foam Corporation.
    b. 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-SSL: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
8. Density: 7.5 lbs/cu. ft.
9. Thermal Conductivity: Not exceeding 0.30 BTU – in/hour sq. ft. ^{o}F at 75^{o}F mean temperature.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

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

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. NOMACO Insulation.

2. Thermal Conductivity: Not exceeding 0.25 BTU-in/hour sq. ft. ^{o}F at 75^{o}F mean temperature.

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

   a. CertainTeed Corp.
   b. Johns Manville.
   c. Knauf Insulation.
   d. Manson Insulation Inc.
   e. Owens Corning; Fiberglas Corp.

2. Density: 3 lbs/cu. ft.
3. Thermal Conductivity: Not exceeding 0.23 BTU-in/hour sq. ft. ^{o}F at 75^{o}F mean temperature

I. Mineral-Fiber, Preformed Pipe Insulation:

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

   a. Johns Manville.
   b. Knauf Insulation.
   c. Manson Insulation Inc.
   d. Owens Corning Fiberglas Corp.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Thermal Conductivity: Not exceeding 0.23 BTU-in/hour sq. ft. ^{o}F at 75^{o}F mean temperature

J. 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

   a. CertainTeed Corp.
   b. Johns Manville.
   c. Knauf Insulation.
   d. Manson Insulation Inc.
   e. Owens Corning Fiberglas Corp.

2. Density: 2.5 lbs/cu. ft.
3. Thermal Conductivity: Not exceeding 0.27 BTU-in/hour ^{o}F at 75^{o}F mean temperature.

K. Molded Close Cell Insulation: Soft resilient molded vinyl with internal ribs complying with ASTM G21 and G22 for bacteria/fungus growth.

1. Acceptable Manufacturers: Subject to compliance with requirements provide product by IFS Corporation; Truebro.

2.2 INSULATING CEMENTS

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

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

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

a. Childers Products, Division of ITW.
b. Foster Products Corporation, H. B. Fuller Company.
c. Marathon Industries, Inc.
d. Mon-Eco Industries, Inc.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

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

a. Aeroflex USA Inc.
b. Armacell LCC.
c. Foster Products Corporation, H. B. Fuller Company.
d. RBX Corporation.

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

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

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

a. Childers Products, Division of ITW.
b. Foster Products Corporation, H. B. Fuller Company.

c. ITW TACC, Division of Illinois Tool Works.
d. Marathon Industries, Inc.
e. Mon-Eco Industries, Inc.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

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

a. Childers Products, Division of ITW.
b. Foster Products Corporation, H. B. Fuller Company.
c. ITW TACC, Division of Illinois Tool Works.
d. Marathon Industries, Inc.
e. Mon-Eco Industries, Inc.

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

F. PVC Jacket Adhesive: Compatible with PVC jacket.

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

a. Dow Chemical Company (The).
b. Johns-Manville; Zeston Perma-Weld.
c. P.I.C. Plastics, Inc.
d. Speedline Corporation.

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

2.4 MASTICS

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

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

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

1. Childers Products, Division of ITW.
2. Foster Products Corporation, H. B. Fuller Company.
3. ITW TACC, Division of Illinois Tool Works.
4. Marathon Industries, Inc.
5. Mon-Eco Industries, Inc.

C. Vapor-Barrier Mastic: Water or solvent based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.05 perm at 43-mi dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.

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

1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. 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. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Products, Division of ITW.
    b. Foster Products Corporation, H. B. Fuller Company.
    c. Marathon Industries, Inc.
    d. Mon-Eco Industries, Inc.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
4. Service Temperature Range: Minus 50 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

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

1. Childers Products, Division of ITW.
2. Foster Products Corporation, H. B. Fuller Company.
3. Marathon Industries, Inc.
4. Mon-Eco Industries, Inc.
5. Pittsburgh Corning Corporation.

B. Joint Sealants for Cellular-Glass:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.

4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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 for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

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

    a. Johns Manville.
    b. P.I.C. Plastics, Inc.
    c. Proto PVC Corporation.
    d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
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.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

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

    a. Childers Products, Division of ITW.
    b. PABCO Metals Corporation.
    c. RPR Products, Inc.

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

    a. Factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and Kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper.
    e. 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. Factory cut and rolled to size.
    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.
e. 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.

2.10 TAPES

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

1. Avery Dennison Corporation, Specialty Tapes Division.
2. Compac Corp.
3. Ideal Tape Co., Inc., an American Biltrite Company.
4. Venture Tape.

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

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

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

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

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
3. 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.
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.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation 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.
3. 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.

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 and piping including fittings, valves, and specialties.

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

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

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

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

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

L. Install insulation with factory-applied jackets 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 as recommended by insulation material manufacturer 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. Manholes.
5. Handholes.
6. 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 Division 07 Section "Penetration Firestopping" and fire-resistive 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 Division 07 Section "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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

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 CELLULAR-GLASS INSULATION INSTALLATION

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 but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe 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 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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 MINERAL-FIBER INSULATION INSTALLATION

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 but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe 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 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.

3.10 FINISHES

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

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

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. 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 (1) 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.
2. 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 (3) locations of straight pipe, locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.12 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.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water and Domestic Chilled Water (Potable):

1. NPS 2 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 2-1/2 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be the following:

a. Molded Closed Cell: 1/2 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

G. Condensate, Drinking Fountain Waste and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

H. Floor Drains/Floor Sinks Bodies and Traps Located in Mechanical Rooms, and Sanitary Drain Piping, from these drains/sinks, up to main risers:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.15 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

3.16 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.

D. Equipment, Exposed:

1. None.

E. Piping, Concealed:

1. None.

F. Piping, Exposed:

1. Aluminum, Smooth: 0.016 inch thick.
2. Stainless Steel, Type 304, Smooth 2B Finish: 0.016 inch thick, for piping located in kitchen areas.

3.17 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.

D. Equipment, Exposed:

1. Aluminum, Corrugated with Z-Shaped Locking Seam: 0.016 inch thick.

E. Piping, Concealed:

1. None.

F. Piping, Exposed:

1. Aluminum, Corrugated with Z-Shaped Locking Seam: 0.016 inch thick.

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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. Specialty valves.
2. Flexible connectors.
3. Escutcheons.
4. Sleeves and sleeve seals.
5. Wall penetration systems.

1.3 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Escutcheons.
6. Sleeves and sleeve seals.
7. Water penetration systems.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components.

C. Comply with NSF 61 for potable domestic water piping and components.

1.5 PROJECT CONDITIONS

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

1. Notify Architect no fewer than seven (7) days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Architect's written permission.

1.6 COORDINATION

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

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.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

5. Copper-Tube Extruded-Tee Connections:

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

        1) T-DRILL Industries Inc.

    b. Description: Tee formed in copper tube according to ASTM F 2014.

6. Grooved-Joint Copper-Tube Appurtenances:

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

        1) Anvil International.
        2) Shurjoint Piping Products.
        3) Victaulic Company.

b. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; 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. Include water-flushable flux according to ASTM B 813.

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

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

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

2.4 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

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

1. American Valve, Inc.
2. Asahi/America, Inc.
3. Fischer, George Inc.
4. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
5. McDonald, A.Y. Mfg. Co.
6. NIBCO INC.

7. Sloane, George Fischer, Inc.
8. Spears Manufacturing Company.
9. Thermoplastic Valves Inc.

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

a. Dresser, Inc.; Dresser Piping Specialties.
b. Ford Meter Box Company, Inc. (The).
c. JCM Industries.
d. Viking Johnson; c/o Mueller Co.

D. Plastic-to-Metal Transition Fittings:

1. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Description: PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

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

1. Calpico, Inc.
2. Capitol Manufacturing Company.
3. Central Plastics Company.
4. EPCO Sales, Inc.
5. Hart Industries International, Inc.
6. Lochinvar Corp.
7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

8. Zurn Plumbing Products Group; Wilkins Water Control Products.

C. Dielectric Unions:

1. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

D. Dielectric Flanges:

1. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

E. Dielectric-Flange Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

F. Dielectric Couplings:

1. Description:

a. Galvanized-steel coupling.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

G. Dielectric Nipples:

1. Description:

a. Electroplated steel nipple complying with ASTM F 1545.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Male threaded or grooved.
d. Lining: Inert and noncorrosive, propylene.

2.7 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew.

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

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

2.8 SLEEVES

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

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

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

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.9 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

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 shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

F. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

G. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

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 adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

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

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: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. 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.

G. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

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

3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger.

Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.
2. NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 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 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.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

J. Install supports for vertical PVC piping every 48 inches.

K. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.

3.8 ESCUTCHEON INSTALLATION

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

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw.
5. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:

1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with set screw or spring clips.
7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.9 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. Galvanized-steel sheet sleeves for pipes smaller than NPS 6.
    b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
    c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.
    b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
    c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
    d. Do not use sleeves when wall penetration systems are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

    a. PVC pipe or Steel pipe sleeves for pipes smaller than NPS 6.
    b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.

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

3.10 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.12 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. 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:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

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

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2. 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.
3. 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.
4. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

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

E. Prepare test and inspection reports.

3.14 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 CLEANING

A. Clean and disinfect potable and non-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. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-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 procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

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

3.16 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. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed or soldered joints.

3.17 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: Calibrated or Memory-stop 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 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Strainers.
5. Outlet boxes.
6. Wall hydrants.
7. Drain valves.
8. Water hammer arresters.
9. Air vents.
10. Trap-seal primer valves.
11. Trap-seal primer systems.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.
3. Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Division 22 Section "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

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

1. Conbraco Industries, Inc.
2. FEBCO; SPX Valves & Controls.
3. Rain Bird Corporation.
4. Toro Company (The); Irrigation Div.
5. Watts Industries, Inc.; Water Products Div.
6. Woodford Manufacturing Company.
7. Zurn Industries, LLC; Wilkins Div.

B. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Chrome plated.

C. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

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

1. Conbraco Industries, Inc.
2. FEBCO; SPX Valves & Controls.
3. McDonald, A.Y. Mfg Co.
4. Mueller Co. Water Products Div.
5. Watts Industries, Inc.; Water Products Div.
6. Zurn Industries, LLC; Wilkins Div.

B. Beverage-Dispensing-Equipment Backflow Preventers:

1. Standard: ASSE 1022.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/4 or NPS 3/8.
4. Body: Stainless steel.
5. End Connections: Threaded.

C. Hose-Connection Backflow Preventers:

1. Standard: ASSE 1052.
2. Operation: Up to 10-foot head of water back pressure.
3. Inlet Size: NPS 1/2 or NPS 3/4.
4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
5. Capacity: At least 3-gpm flow.

2.3 BALANCING VALVES

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

1. Crane Company.
2. ITT Industries; Bell & Gossett Div.
3. Milwaukee Valve Co.
4. NIBCO INC.
5. Taco, Inc.
6. Watts Industries, Inc.; Water Products Div.

B. Copper-Alloy Calibrated Balancing Valves:

1. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
2. Body: Brass or bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Cast-Iron Calibrated Balancing Valves:

1. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
2. Size: Same as connected piping, but not smaller than NPS 2-1/2.

D. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

E. Memory-Stop Balancing Valves:

1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 2 or smaller.
4. Body: Copper alloy.
5. Port: Full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

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

1. Armstrong International, Inc.
2. Lawler Manufacturing Co., Inc.
3. Powers; a Watts Industries Co.
4. Symmons Industries, Inc.

B. Individual-Fixture, Water Tempering Valves:

1. Standard: ASSE 1016, thermostatically controlled water tempering valve.
2. Pressure Rating: 125 psig minimum, unless otherwise indicated.
3. Body: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: Threaded.
6. Finish: Rough or chrome-plated bronze.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.6 OUTLET BOXES

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

1. Acorn Engineering Company.
2. Guy Gray Manufacturing Co., Inc.
3. Symmons Industries, Inc.
4. Watts Industries, Inc.; Water Products Div.
5. Whitehall Manufacturing; a div. of Acorn Engineering Company.
6. Zurn Industries, LLC; Light Commercial Operation.

B. Icemaker Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Stainless-steel box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.7 WALL HYDRANTS

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

1. Josam Company.
2. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.
5. Woodford Manufacturing Company.
6. Zurn Industries, LLC; Specification Drainage Operation.

B. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounting with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): One with each wall hydrant.

C. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
5. Inlets: NPS 3/4 or NPS 1.
6. Outlet: Concealed.
7. Box: Deep, flush mounting with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Vacuum Breaker: Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 and with garden-hose thread complying with ASME B1.20.7 on outlet.
10. Operating Keys(s): One with each wall hydrant.

D. Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4. Pressure Rating: 125 psig.
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 1/2 or NPS 3/4.
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER HAMMER ARRESTERS

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

1. AMTROL, Inc.
2. Josam Company.
3. Sioux Chief Manufacturing Company, Inc.
4. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

5. Tyler Pipe; Wade Div.
6. Watts Drainage Products Inc.
7. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows.
3. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.11 TRAP-SEAL PRIMER VALVES

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

1. MIFAB, Inc.
2. PPP Inc.
3. Sioux Chief Manufacturing Company, Inc.
4. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
5. Watts Industries, Inc.; Water Products Div.

B. Supply-Type, Trap-Seal Primer Valves:

1. Standard: ASSE 1018.
2. Pressure Rating: 125 psig minimum.
3. Body: Bronze.
4. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
5. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

C. Drainage-Type, Trap-Seal Primer Valves:

1. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
2. Size: NPS 1-1/4 minimum.
3. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

H. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

I. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install shutoff valve on outlet if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

J. Install ground hydrants with minimum 1 cu. yd. of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

K. Install draining-type post hydrants with minimum 1 cu. yd. of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.

L. Install water hammer arresters in water piping according to PDI-WH 201.

M. Install air vents at high points of water piping.

N. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

O. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

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

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

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check backflow-prevention assemblies.
5. Carbonated-beverage-machine backflow preventers.
6. Dual-check-valve backflow preventers.
7. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
8. Double-check, detector-assembly backflow preventers.
9. Water pressure-reducing valves.
10. Calibrated balancing valves.
11. Primary, thermostatic, water mixing valves.
12. Manifold, thermostatic, water-mixing-valve assemblies.
13. Photographic-process, thermostatic, water-mixing-valve assemblies.
14. Primary water tempering valves.
15. Outlet boxes.
16. Hose stations.
17. Supply-type, trap-seal primer valves.
18. Trap-seal primer systems.

B. 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 Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

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. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.
3. Encasement for underground metal piping.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 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.
2. Sanitary Sewer, Force-Main Piping: 50 psig.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Solvent Drainage System: Include plans, elevations, sections, and details.

D. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. 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; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

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

A. Pipe and Fittings: ASTM A 74, Service class.

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. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
2. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Section "Common Work Results for Plumbing" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
5. Copper DWV tube, copper drainage fittings, and soldered joints.
6. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings, heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings gaskets, and gasketed joints.
5. Copper DWV tube, copper drainage fittings, and soldered joints.

a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

6. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; and heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

F. Underground, soil, waste, and vent piping shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

3.3 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

G. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

H. 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.

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not

change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. 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.

C. 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.

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

F. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

1. Install gate or full-port ball valve for piping NPS 2 and smaller.
2. 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 sewage 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.
4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 3: 96 inches with 1/2-inch rod.
3. NPS 4: 108 inches with 1/2-inch rod.
4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

M. Install supports for vertical copper tubing every 10 feet.

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.8 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. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains 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.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Metal cleanouts.
3. Plastic cleanouts.
4. Floor drains.
5. Air-admittance valves.
6. Roof flashing assemblies.
7. Through-penetration firestop assemblies.
8. Miscellaneous sanitary drainage piping specialties.
9. Flashing materials.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Division 22 Section "Plumbing Fixtures" for hair interceptors.
3. Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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

    a. Josam Company; Josam Div.
    b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
    c. Tyler Pipe; Wade Div.
    d. Watts Drainage Products Inc.
    e. Zurn Industries, LLC; Specification Drainage Operation.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

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

a. Josam Company; Josam Div.
b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
c. Watts Drainage Products Inc.
d. Zurn Industries, LLC; Specification Drainage Operation.

2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.2 METAL CLEANOUTS

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

1. Josam Company; Josam Div.
2. Josam Company; Blucher-Josam Div.
3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.
6. Zurn Industries, LLC; Specification Drainage Operation.

B. Exposed Metal Cleanouts:

1. Standard: ASME A112.36.2M for cast iron/ASME A112.3.1 for stainless steel for cleanout test tee.
2. Size: Same as connected drainage piping
3. Body Material: As required to match connected piping.
4. Closure: Raised-head, brass or cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Closure: Stainless-steel plug with seal.

C. Metal Floor Cleanouts:

1. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Heavy-duty, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Required.
6. Outlet Connection: Inside calk/Spigot.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
13. Standard: ASME A112.3.1.

14. Size: Same as connected branch.
15. Housing: Stainless steel.
16. Closure: Stainless steel with seal.
17. Riser: Stainless-steel drainage pipe fitting to cleanout.

D. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: As required to match connected piping.
4. Closure: Raised-head, brass or cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, cover plate with screw.

2.3 FLOOR DRAINS

A. Floor Drains:

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

   a. Josam Company; Josam Div.
   b. Josam Company; Blucher-Josam Div.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Industries, LLC; Light Commercial Operation.
   g. Zurn Industries, LLC; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
3. Body Material: Gray iron/Stainless Steel.
4. Seepage Flange: Required.
5. Clamping Device: Required.
6. Outlet: Bottom or Side.
7. Backwater Valve: Integral, ASME A112.14.1, swing-check type where specified.
8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Where specified.
10. Top or Strainer Material: Gray iron/Nickel bronze/Stainless steel.
11. Top of Body and Strainer Finish: Gray iron/Nickel bronze/Stainless steel.
12. Top Shape: Round.
13. Dimensions of Top or Strainer: Minimum 8 inch diameter.
14. Top Loading Classification: Extra Heavy-Duty/Heavy Duty/Light Duty/Medium Duty.
15. Funnel: Where specified.
16. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet. Trap-seal primer valve connection where shown on drawings.
17. Trap Material: Cast iron.
18. Trap Pattern: Standard P-trap.
19. Trap Features: Cleanout.

2.4 AIR-ADMITTANCE VALVES

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

1. Durgo, Inc.
2. Oatey.
3. ProSet Systems Inc.
4. RectorSeal.
5. Studor, Inc.

B. Fixture Air-Admittance Valves:

1. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
2. Housing: Plastic.
3. Operation: Mechanical sealing diaphragm.
4. Size: Same as connected fixture or branch vent piping.

C. Stack Air-Admittance Valves:

1. Standard: ASSE 1050 for vent stacks.
2. Housing: Plastic.
3. Operation: Mechanical sealing diaphragm.
4. Size: Same as connected stack vent or vent stack.

D. Wall Box:

1. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
2. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.5 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft. thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2: 4-inch- minimum water seal.
    b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.8 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft. thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet.
4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. 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. 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.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

G. Install fixture air-admittance valves on fixture drain piping.

H. Install stack air-admittance valves at top of stack vent and vent stack piping.

I. Install air-admittance-valve wall boxes recessed in wall.

J. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

K. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

L. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

M. Assemble open drain fittings and install with top of hub 2 inches above floor.

N. Install deep-seal traps on floor drains and other waste outlets, if indicated.

O. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

P. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

Q. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

R. Install wood-blocking reinforcement for wall-mounting-type specialties.

S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

T. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain interceptors. Refer to Division 01 Section "Demonstration and Training."

3.7 FLOOR DRAINS/SINKS SCHEDULE

A. Floor Drains Schedule:

1. Unfinished Areas on Grade:

a. Body Material: Gray iron.
b. Top of Body and Strainer Finish: Gray iron.
c. Strainer Material: Gray iron.
d. Top Loading Classification: Extra heavy duty.
e. Integral Tray and Cleanout: Required.
f. Backwater Valve: Required.

2. Unfinished Areas above Ground:

a. Body Material: Gray iron.
b. Top of Body and Strainer Finish: Gray iron.
c. Top Loading Classification: Extra heavy duty.
d. Strainer Material: Gray iron.
e. Integral Trap and Cleanout: Required.

3. Finished Areas on Grade.

a. Body Material: Gray iron.
b. Top of Body and Strainer: Nickel bronze.
c. Top Loading Classifications: Light duty.
d. Integral Trap and Cleanout: Required.
e. Backwater Valve: Required.

4. Finished Areas above Grade:

a. Body Material: Gray iron.
b. Top of Body and Strainer Finish: Nickel bronze.
c. Top Loading Classification: Light duty.
d. Strainer Material: Nickel bronze.

5. Mechanical Rooms on Grade:

a. Body Material: Gray iron.
b. Top of Body and Strainer Finish: Gray iron.
c. Top Loading Classification: Extra heavy duty.
d. Strainer Material: Gray iron.
e. Trap and Cleanout: Required.
f. Backwater Valve: Required.
g. Sediment Bucket: Aluminum.
h. Drain with 9” deep sump.

6. Mechanical Rooms above Grade:

a. Body Material: Gray iron.
b. Top of Body and Strainer Finish: Gray iron.
c. Top Loading Classification: Extra heavy duty.
d. Strainer Material: Gray iron.
e. Sediment Bucket: Aluminum.
f. Drain with 9” deep sump.

7. Funnel Floor Drains: Same as floor drains specified above, but with elongated 8x3 funnel.

END OF SECTION

SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections include the following:

1. Division 22 Section "Sump Pumps."

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.
2. Storm Drainage, Force-Main Piping: 50 psig.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

D. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

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

A. Pipe and Fittings: ASTM A 74, Service class.

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. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
2. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

2.5 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Center-Sleeve Material: Manufacturer's standard.
2. Gasket Material: Natural or synthetic rubber.
3. Metal Component Finish: Corrosion-resistant coating or material.

E. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Section "Common Work Results for Plumbing" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.

D. Underground storm drainage piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

F. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

G. 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.

H. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

J. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 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 Storm-Drainage Piping: 2 percent downward in direction of flow.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate or full-port ball valve for piping NPS 2 and smaller.
2. 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 sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.
2. Install backwater valves in accessible locations.
3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.

4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

K. Install supports for vertical copper tubing every 10 feet.

L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main or storm manhole.
2. Sump Pumps: To sump pump discharge.

3.8 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.
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. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage 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. 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains 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.

END OF SECTION

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping specialties:

1. Metal cleanouts.
2. Through-penetration firestop assemblies.
3. Roof drains.
4. Miscellaneous storm drainage piping specialties.
5. Flashing materials.

B. Related Sections include the following:

1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, grease interceptors, oil interceptors, and solid interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PUR: Polyurethane plastic.

H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 METAL CLEANOUTS

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

1. Josam Company; Josam Div.
2. Josam Company; Blucher-Josam Div.
3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.
6. Zurn Industries, LLC; Specification Drainage Operation.

B. Exposed Metal Cleanouts:

1. Standard: ASME A112.36.2M for cast iron/ASME A112.3.1 for stainless steel for cleanout test tee.
2. Size: Same as connected drainage piping
3. Body Material: As required to match connected piping.
4. Closure: Brass or cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Closure: Stainless-steel plug with seal.

C. Metal Floor Cleanouts:

1. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Heavy-duty, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Required.
6. Outlet Connection: Inside calk/Spigot.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
13. Standard: ASME A112.3.1.
14. Size: Same as connected branch.
15. Housing: Stainless steel.
16. Closure: Stainless steel with seal.

17. Riser: Stainless-steel drainage pipe fitting to cleanout.

D. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: As required to match connected piping.
4. Closure: Brass or cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat or stainless-steel cover plate with screw.

2.2 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected pipe.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.3 ROOF DRAINS

A. Metal Roof Drains:

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

   a. Thaler Metal Industries Ltd.
   b. Josam Company; Josam Div.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Industries, LLC; Light Commercial Operation.
   g. Zurn Industries, LLC; Specification Drainage Operation.

2. Standard: ASME A112.21.2M.
3. Pattern: Balcony/Canopy/Promenade-deck/Roof/Scupper drain.
4. Body Material: Cast iron.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Flow-Control Weirs: Not required.
7. Outlet: Bottom or Side.
8. Dome Material: Cast iron or PE.
9. Extension Collars: Required.
10. Underdeck Clamp: Required.
11. Sump Receiver: Not required.

2.4 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

2.5 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

F. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

H. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

I. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

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 ROOF DRAINS SCHEDULE

A. Roof Drain/Overflow Roof Drain Schedule:

1. Roof Drain:

   a. Dome Material: Cast iron for all sizes.
   b. Dome Material: Polypropylene for sizes up to 6 inches.

2. Overflow Roof Drain:

   a. Dome Material: Cast iron for all sizes.
   b. Dome Material: Polypropylene for sizes up to 6 inches.
   c. 2” Dam: Required.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for lavatories, bathtub/showers and sinks.
2. Laminar-flow faucet-spout outlets.
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Water closets.
8. Urinals.
9. Lavatories.
10. Commercial sinks.
11. Individual showers.
12. Janitor’s sinks.

B. Related Sections include the following:

1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
3. Division 22 Section "Domestic Water Filtration Equipment" for water filters.
4. Division 22 Section "Healthcare Plumbing Fixtures."
5. Division 22 Section "Emergency Plumbing Fixtures."
6. Division 22 Section "Drinking Fountains and Water Coolers."
7. Division 31 Section "Facility Water Distribution Piping" for exterior plumbing fixtures and hydrants.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Plastic Laundry Trays: ANSI Z124.6.
3. Plastic Shower Enclosures: ANSI Z124.2.
4. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
5. Slip-Resistant Bathing Surfaces: ASTM F 462.
6. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
7. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
8. Stainless-Steel Residential Sinks: ASME A112.19.3.
9. Vitreous-China Fixtures: ASME A112.19.2M.
10. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
11. Water-Closet, Flushometer Tank Trim: ASSE 1037.
12. Whirlpool Bathtub Fittings: ASME A112.19.8M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Manual-Operation Flushometers: ASSE 1037.
4. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Dishwasher Air-Gap Fittings: ASSE 1021.
2. Flexible Water Connectors: ASME A112.18.6.
3. Floor Drains: ASME A112.6.3.
4. Grab Bars: ASTM F 446.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.
b. Faulty operation of controls, blowers, pumps, heaters, and timers.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Commercial Applications: One (1) year from date of final acceptance by Owner.

1.7 EXTRA MATERIALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed, but less than 2.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed but not less than 2.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.
4. Flushometer Tank, Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than 2 of each type.
5. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
6. Toilet Seats: Equal to 5 percent of amount of each type installed, but not less than 2.

PART 2 - PRODUCTS

2.1 FAUCETS

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

1. American Standard Companies, Inc.
2. Bradley Corporation.
3. Chicago Faucets.
4. Delta Faucet Company.
5. Eljer.
6. Kohler Co.
7. Moen, Inc.
8. Royal Brass Mfg. Co.
9. Speakman Company.
10. T & S Brass and Bronze Works, Inc.
11. Zurn Industries, LLC; Commercial Brass Operation.

B. Description: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

1. Body Material: Commercial, solid brass.
2. Finish: Polished chrome plate.
3. Maximum Flow Rate: 2.5 gpm unless rated otherwise.

2.2 LAMINAR-FLOW FAUCET-SPOUT OUTLETS

A. Laminar-Flow Faucet-Spout Outlets:

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

2.3 FLUSHOMETERS

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

1. Delta Faucet Company.
2. MOCA, Inc.
3. Sloan Valve Company.
4. TOTO USA, Inc.
5. Zurn Industries, LLC; Commercial Brass Operation.

B. Description: Flushometer for urinal or water-closet-type fixture. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

2.4 TOILET SEATS

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

1. American Standard Companies, Inc.
2. Bemis Manufacturing Company.
3. Church Seats.
4. Eljer.
5. Kohler Co.
6. Olsonite Corp.
7. Sanderson Plumbing Products, Inc.; Beneke Div.
8. Zurn Industries, LLC; Commercial Fixtures.

B. Description: Toilet seat for water-closet-type fixture.

1. Material: Molded, solid plastic with antimicrobial agent.
2. Configuration: Open front with cover.
3. Size: Elongated.
4. Hinge Type: stainless steel**,** self-sustaining, external check.
5. Color: White, unless noted otherwise.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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

   a. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
   b. McGuire Manufacturing Co., Inc.
   c. TRUEBRO, Inc.
   d. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

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

   a. TRUEBRO, Inc.
   b. Sloan Valve Co.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.6 FIXTURE SUPPORTS

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

1. Josam Company.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
5. Zurn Industries, LLC; Specification Drainage Operation.

B. Water-Closet Supports:

1. Description: Combination carrier designed for mounting height of wall-mounting or floor mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space. Support shall be designed to withstand minimum 300 lbs. weight on fixture.

C. Lavatory Supports:

1. Description: Type for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.7 WATER CLOSETS

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

1. Crane Plumbing, L.L.C./Fiat Products.
2. American Standard Companies, Inc.
3. Eljer.
4. Kohler Co.
5. TOTO USA, Inc.
6. Zurn Industries, LLC; Commercial Fixtures.

B. Description Wall/Floor-mounting, back/floor-outlet, vitreous-china fixture designed for operation. Minimum 300 lbs. weight capacity. Fixture shall be ADA compatible where specified.

1. Bowl Type: Elongated with siphon-jet design.
2. Design Consumption: Maximum 1.6 gal./flush.
3. Color: White, unless noted otherwise.

2.8 LAVATORIES

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

1. American Standard Companies, Inc.
2. Eljer.
3. Crane Plumbing, L.L.C./Fiat Products.
4. Gerber Plumbing Fixtures LLC.
5. Kohler Co.
6. TOTO USA, Inc.
7. Zurn Industries, LLC; Commercial Fixtures.

B. Description: Wall or Counter -mounting, vitreous-china fixture.

1. Color: White, unless noted otherwise.

2.9 COMMERCIAL SINKS

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

1. American Standard Co., Inc.
2. Elkay Manufacturing Co.
3. Just Manufacturing Company.
4. Kohler Co.
5. Marlo Manufacturing.

B. Description: Counter-mounting/Wall mounting, stainless-steel commercial sink fixture.

1. Material: 18 gauge, type 304. Stainless steel with satin finish.
2. Type: Self-rimming for counter mounting, with back-splash for wall mounting.
3. Number of Compartment: As shown on drawings.

2.10 INDIVIDUAL SHOWERS

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

1. Aqua Glass Corporation.
2. Best Bath Systems.
3. Clarion Bathware.
4. Crane Plumbing, L.L.C./Fiat Products.
5. Florestone Products Co., Inc.
6. Jacuzzi, Inc.
7. Kohler Co.

B. Description: Shower enclosure with slip-resistant bathing surface and shower rod with curtain.

1. Color: White, unless noted otherwise.
2. Accessibility Options: Include grab bar and bench.

2.11 JANITOR'S SINKS

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

1. Acorn Engineering Company.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Florestone Products Co., Inc.
4. Precast Terrazzo Enterprises, Inc.
5. Stern-Williams Co., Inc.
6. Zurn Industries, LLC; Light Commercial Operation.

B. Description: Flush-to-wall, floor-mounting, precast terrazzo fixture with rim guard.

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 plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

R. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

S. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

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

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

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers/hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 43 00

HEALTHCARE PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following medical plumbing fixtures and related components:

1. Faucets for lavatories, showers and sinks.
2. Laminar-flow, faucet-spout outlets.
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Bedpan washers.
8. Water closets.
9. Lavatories.
10. Clinical sinks.
11. Bedpan washing equipment.

B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
2. Division 22 Section "Sanitary Waste Piping Specialties" for floor drains.
3. Division 22 Section "Plumbing Fixtures" for conventional plumbing fixtures.
4. Division 22 Section "Emergency Plumbing Fixtures."

1.3 DEFINITIONS

A. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

1.4 SUBMITTALS

A. Product Data: For each type of medical plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For medical plumbing fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain medical plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Plastic Shower Enclosures: ANSI Z124.2.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Vitreous-China Fixtures: ASME A112.19.2M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
3. Faucets: ASME A112.18.1.
4. Hose-Connection Vacuum Breakers: ASSE 1011.
5. Hose-Coupling Threads: ASME B1.20.7.

6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
7. NSF Materials: NSF 61.
8. Pipe Threads: ASME B1.20.1.
9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
10. Supply Fittings: ASME A112.18.1.
11. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Flexible Water Connectors: ASME A112.18.6.
4. Manual-Operation Flushometers: ASSE 1037.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Brass Waste Fittings: ASME A112.18.2.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Grab Bars: ASTM F 446.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Toilet Seats: ANSI Z124.5.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 EXTRA MATERIALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed, but not less than 2.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed, but not less than 2.

3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 6 of each type.
4. Toilet Seats: Equal to 5 percent of amount of each type installed, but not less than 2.

PART 2 - PRODUCTS

2.1 FAUCETS

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

1. American Standard Companies, Inc.
2. Bradley Corporation.
3. Chicago Faucets.
4. Delta Faucet Company.
5. Eljer.
6. Kohler Co.
7. Moen, Inc.
8. Royal Brass Mfg. Co.
9. Speakman Company.
10. T & S Brass and Bronze Works, Inc.
11. Zurn Industries, LLC; Commercial Brass Operation.

B. Description: Faucet for lavatory-type medical plumbing fixture. Coordinate faucet inlets with supplies, connectors, and fixture holes; coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 2.2 gpm unless noted otherwise.
2. Body Material: Solid brass.
3. Finish: Polished chrome plate.
4. Temperature Indicators: Color-coded for hot and cold water.

2.2 LAMINAR-FLOW FAUCET-SPOUT OUTLETS

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

2.3 FLUSHOMETERS

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

1. Delta Faucet Company.
2. Moen, Inc.
3. Sloan Valve Company.
4. TOTO USA, Inc.
5. Zurn Industries, LLC; Commercial Brass Operation.

B. Description: Flushometer for clinical-sink or urinal or water-closet-type medical plumbing fixture. Include brass body with corrosion-resistant internal components, control stop with check

valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.

1. Internal Design: Diaphragm operation.
2. Consumption: 1.6 gal./flush unless noted otherwise.
3. Integral Bedpan Washer: Where shown on drawings.

2.4 TOILET SEATS

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

1. Bemis Manufacturing Company.
2. Church Seats.
3. Olsonite Corp.
4. Sanderson Plumbing Products, Inc.; Beneke Div.
5. Zurn Industries, LLC; Commercial Fixtures.

B. Description: Plastic toilet seat for water-closet-type medical plumbing fixture.

1. Material: Molded, solid plastic with antimicrobial agent.
2. Configuration: Open front with cover.
3. Size: Elongated, unless otherwise indicated.
4. Class: Heavy-duty commercial.
5. Hinge Type: Stainless-steel SC, self-sustaining check.
6. Color: White.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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

a. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
b. McGuire Manufacturing Co., Inc.
c. TRUEBRO, Inc.
d. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering medical plumbing fixture and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

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

a. TRUEBRO, Inc.
b. Sloan Valve Co.

2. Description: Manufactured plastic enclosure for covering medical plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.6 FIXTURE SUPPORTS

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

1. Josam Company.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
5. Zurn Industries, LLC; Specification Drainage Operation.

B. Water-Closet Supports:

1. Description: Combination carrier designed for mounting height of wall-mounting or floor mounting, water-closet-type medical plumbing fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space. Support shall be designed to withstand minimum 500 lbs. weight on fixture.

C. Lavatory Supports:

1. Description: Type for wall-mounting, lavatory-type medical plumbing fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Sink Supports:

1. Description: Type for sink-type medical plumbing fixture. Include steel uprights with feet.

2.7 BEDPAN WASHERS

A. Bedpan Washers:

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

a. American Standard Companies, Inc.
b. Chicago Faucets.
c. Crane Plumbing, L.L.C./Fiat Products.
d. Delta Faucet Company.
e. Eljer.
f. Kohler Co.
g. T & S Brass and Bronze Works, Inc.
h. Zurn Industries, LLC; Commercial Brass Operation.

2. Description: Wall-mounting, hand-held, single-pedal, foot-control, medical plumbing fixture.

a. Hose: 48-inch- long rubber or vinyl hose with spray nozzle, wall bracket, and hook.
b. Self-closing valve.
c. Loose-key supply stop.

d. Vacuum Breaker: Wall mounting, atmospheric.
e. Finish: Polished, chrome-plated finish on metal parts exposed after installation.

2.8 WATER CLOSETS

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

1. American Standard Companies, Inc.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Eljer.
4. Kohler Co.
5. Zurn Industries, LLC; Commercial Fixtures.

B. Description: Wall/Floor-mounting, back/floor-outlet, vitreous-china medical plumbing fixture designed for bedpan washing (where specified), flushometer valve operation and minimum 500 lbs. weight capacity. Fixture shall be ADA compatible where specified.

a. Style: Flushometer valve.

1) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots.
2) Design Consumption: 1.6 gal./flush.
3) Color: White unless noted otherwise.

2.9 LAVATORIES

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

1. American Standard Companies, Inc.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Eljer.
4. Gerber Plumbing Fixtures LLC.
5. Kohler Co.
6. Zurn Industries, LLC; Commercial Fixtures.

B. Description: Wall-mounting, vitreous-china medical plumbing fixture.

1. Color: White, unless noted otherwise.

2.10 SINKS

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

1. American Standard Co., Inc.
2. Elkay Manufacturing Co.
3. Just Manufacturing Company.
4. Kohler Co.
5. Marlo Manufacturing.

B. Description: Counter-mounting/Wall mounting, stainless-steel sink fixture.

1. Material: 18 gauge, type 304. Stainless steel with satin finish.
2. Type: Self-rimming for counter mounting, with back-splash for wall mounting.
3. Number of Compartment: As shown on drawings.

2.11 CLINICAL SINKS

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

1. American Standard Companies, Inc.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Eljer.
4. Kohler Co.
5. Zurn Industries, LLC; Commercial Fixtures.

B. Description: Wall-mounting, back-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture.

1. Color: White.
2. Rim Guard: Stainless steel on front and also on sides if flat rim.

2.12 OUTLET BOXES

A. Dialysis Equipment Outlet Boxes:

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

a. Acorn Engineering Company.
b. Bradley Corporation.
c. Metcraft Industries Inc.
d. Whitehall Manufacturing; a division of Acorn Manufacturing Company.

2. Description: Recessed-mounting outlet box with water supply and drain connections.

a. Box and Faceplate: Stainless steel.
b. Supply Fitting(s): NPS 1/2 PVC ball valve(s) and adapter with male hose-thread outlet.
c. Drain: NPS standpipe, P-trap, and direct waste connection to drainage piping.

3. Reinforcement: 2-by-4-inch fire-retardant-treated-wood blocking between studs. Fire-retardant-treated wood blocking is specified in Division 06 Section "Rough Carpentry."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for medical plumbing fixtures to verify actual locations of piping connections before fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install shower flow-control fittings with specified maximum flow rates in shower arms.

N. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

O. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

P. Set showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from domestic water piping to medical plumbing fixtures.

C. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.

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

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

3.4 FIELD QUALITY CONTROL

A. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.

B. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning medical plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of medical plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 61 13

COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Medical air piping and specialties, designated "medical air," operating at 50 to 55 psig.
2. Healthcare laboratory air piping and specialties, designated "medical laboratory air," operating at 100 psig.

B. Related Sections include the following:

1. Division 12 Section "Healthcare Casework" for compressed-air outlets in medical casework.
2. Division 22 Section "General-Service Compressed-Air Piping" for general-service compressed-air piping.
3. Division 22 Section "Compressed-Air Equipment for Laboratory and Healthcare Facilities" for laboratory air and medical air compressors.

1.3 DEFINITIONS

A. D.I.S.S.: Diameter-index safety system.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. Medical Compressed-Air Piping Systems: Include medical air, dental air and medical laboratory air piping systems.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Compressed-air tubes and fittings.
2. Compressed-air valves and valve boxes.
3. Medical compressed-air service connections.
4. Medical compressed-air pressure control panels.
5. Medical compressed-air manifolds.
6. Medical compressed-air alarm system components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.

D. Qualification Data: For testing agency.

E. Brazing certificates.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

E. 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.

F. ASME Compliance:

1. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig or less.

G. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Laboratory and Medical Compressed-Air Service(s): Do not interrupt laboratory or medical compressed-air 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 Architect no fewer than seven days in advance of proposed interruption of laboratory and medical compressed-air service(s).
2. Do not proceed with interruption of laboratory and medical compressed-air service(s) without Architect's written permission.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

1.8 EXTRA MATERIALS

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

1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets.

    a. Medical Compressed-Air Service Connections: Equal to ten percent of amount installed, but no fewer than two units.

2. D.I.S.S. Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets complying with CGA V-5.

    a. Compressed-Air D.I.S.S. No. 1160: Equal to ten percent of amount installed, but no fewer than two units.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
4. Press-Type Fittings:

    a. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    b. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

B. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

C. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.

1. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.
2. Press-Type Fittings:

    a. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    b. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

2.2 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

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

C. Threaded-Joint Tape: PTFE.

D. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

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

1. Amico Corporation.
2. BeaconMedaes.

C. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

1. Pressure Rating: 300 psig minimum.
2. Ball: Full-port, chrome-plated brass.
3. Seats: PTFE or TFE.

4. Handle: Lever type with locking device.
5. Stem: Blowout proof with PTFE or TFE seal.
6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Check Valves: In-line pattern, bronze.

1. Pressure Rating: 300 psig minimum.
2. Operation: Spring loaded.
3. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

E. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

1. Pressure Rating: 300 psig minimum.
2. Ball: Full-port, chrome-plated brass.
3. Seats: PTFE or TFE.
4. Handle: Lever type with locking device.
5. Stem: Blowout proof with PTFE or TFE seal.
6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
7. Pressure Gage: Manufacturer installed on one copper-tube extension.

F. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

1. Interior Finish: Factory-applied white enamel.
2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

H. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

I. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.

2.4 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS

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

1. Amico Corporation.
2. BeaconMedaes.

B. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:

    a. Steel outlet box for recessed mounting and concealed piping.
    b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
    c. Double seals that will prevent air leakage.
    d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:

    a. Brass housing with primary check valve.
    b. Double seals that will prevent air leakage.
    c. Cover plate with gas-service label.

3. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
4. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

    a. Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
    b. Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.

5. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish or anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL COMPRESSED-AIR PRESSURE CONTROL PANELS

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

1. Amico Corporation.
2. BeaconMedaes.

B. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.

1. Minimum Working Pressure: 200 psig.
2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
3. Pressure Gages: 0- to 300-psig range.
4. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
5. Before final assembly, provide temporary dust shield and U-tube for testing.
6. Label cover plate "Air Pressure Control."

2.6 MEDICAL COMPRESSED-AIR MANIFOLDS

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

1. Amico Corporation.
2. BeaconMedaes.

B. General Requirements for Medical Compressed-Air Manifolds: Comply with NFPA 99, Ch. 5, "Manifolds for Gas Cylinders without Reserve Supply."

C. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.

D. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

E. Compressed-Air Cylinders: Will be furnished by Owner.

F. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.

G. Mounting: Wall with mounting brackets for manifold control cabinet and headers/Floor with support legs for manifold control cabinet.

H. Label manifold control unit with permanent label identifying compressed air and system operating pressure.

I. Medical Air Manifolds: For number of cylinders and capacity at 55-psig line pressure.

2.7 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

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

1. Amico Corporation.
2. BeaconMedaes.

B. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed

valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.

E. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Low-Pressure Operating Range: 0- to 100-psig.
2. High-Pressure Operating Range: Up to 250-psig.

F. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

G. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting: Recessed installation.
2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

H. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

1. Include alarm signals when the following condition exists:

a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.

2.8 FLEXIBLE PIPE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Hyspan Precision Products, Inc.
4. Metraflex, Inc.
5. Unaflex.
6. Universal Metal Hose; a Hyspan Co.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: 200 psig minimum.
2. End Connections: Threaded copper pipe or plain-end copper tube.

2.9 SLEEVES

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

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.10 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.11 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.

    a. Scrub to ensure complete cleaning.
    b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Dental Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Medical Laboratory Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

E. Drain Piping: Use one of the following piping materials:

1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Comply with ASSE Standard #6010 for installation of compressed-air piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install air and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install medical compressed-air piping to medical compressed-air service connections specified in this Section, to medical compressed-air service connections in equipment specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities," and to equipment specified in other Sections requiring medical compressed-air service.

P. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

S. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.

B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.

F. Install pressure regulators on compressed-air piping where reduced pressure is required.

G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.

H. Install flexible pipe connectors in discharge piping of each air compressor.

3.5 JOINT CONSTRUCTION

A. Ream ends of PVC pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

F. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.

G. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

H. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Apply primer and join according to ASME B31.9 for solvent-cemented joints, and ASTM D 2672.

3.6 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION

A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.

B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.

C. Install area and master alarm panels for medical compressed-air piping system where indicated.

D. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

3.7 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe/stack sleeve fittings.

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

2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than NPS 6.
2. Steel Sheet Sleeves: For pipes NPS 6 and larger penetrating gypsum board partitions.
3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

    a. Seal space outside of sleeve fittings with grout.

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

3.8 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
    b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
    c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
    d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with rough-brass finish, stamped steel with set screw or spring clips.
    e. Bare Piping in Equipment Rooms: One piece, cast brass stamped steel with set screw or spring clips.
    f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

2. Existing Piping:

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

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.10 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Air: Black letters on yellow background.
2. Dental Air: Black letters on yellow-and-white diagonal stripe background.
3. Medical Laboratory Air: Black letters on yellow-and-white checkerboard background.

3.11 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

    a. Initial blowdown.
    b. Initial pressure test.
    c. Cross-connection test.
    d. Piping purge test.
    e. Standing pressure test for positive-pressure medical compressed-air piping.
    f. Repair leaks and retest until no leaks exist.

3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:

    a. Standing pressure test.
    b. Individual-pressurization or pressure-differential cross-connection test.
    c. Valve test.
    d. Master and area alarm tests.
    e. Piping purge test.
    f. Piping particulate test.
    g. Piping purity test.
    h. Final tie-in test.
    i. Operational pressure test.
    j. Medical air purity test.
    k. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

    a. Inspections performed.
    b. Procedures, materials, and gases used.

c. Test methods used.
d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 62 13

VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 20 inches mercury.
2. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 15 inches mercury.
3. Dental vacuum piping and specialties, designated "dental vacuum" operating at 12 inches mercury.
4. Healthcare laboratory vacuum piping and specialties, designated "medical laboratory vacuum" operating at 20 inches mercury.

B. Related Sections include the following:

1. Division 12 Section "Healthcare Casework" for vacuum outlets in metal medical casework.
2. Division 22 Section "Vacuum Equipment for Laboratory and Healthcare Facilities" for medical and dental vacuum producers.

1.3 DEFINITIONS

A. D.I.S.S.: Diameter-index safety system.

B. HVE: High-volume (oral) evacuation.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. WAGD: Waste anesthetic gas disposal.

E. Medical vacuum piping systems include medical vacuum, WAGD evacuation, dental vacuum and medical laboratory vacuum piping systems.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Vacuum pipes, tubes and fittings.
2. Vacuum valves and valve boxes.
3. Medical vacuum service connections and vacuum-bottle brackets.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer.

E. Brazing certificates.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
2. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
3. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

E. 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.

F. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.

G. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Laboratory and Medical Vacuum Service(s): Do not interrupt laboratory or medical vacuum 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 Architect no fewer than seven days in advance of proposed interruption of laboratory and medical vacuum service(s).
2. Do not proceed with interruption of laboratory and medical vacuum service(s) without Architect's written permission.

1.7 COORDINATION

A. Coordinate medical vacuum service connections with other service connections. Medical compressed-air service connections are specified in Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

1.8 EXTRA MATERIALS

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

1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical vacuum suction inlets.

    a. Medical Vacuum Service Connections: Equal to 10 percent of amount installed, but no fewer than two units.
    b. WAGD Evacuation Service Connections: Equal to 10 percent of amount installed, but no fewer than two units.

2. D.I.S.S. Connections: Furnish complete noninterchangeable medical vacuum suction inlets complying with CGA V-5.

    a. Medical Vacuum D.I.S.S. No. 1220: Equal to 10 percent of amount installed, but no fewer than two units.
    b. WAGD Evacuation D.I.S.S. No. 2220: Equal to 10 percent of amount installed, but no fewer than two units.

3. Medical Vacuum Bottle Brackets: Equal to 10 percent of amount installed, but no fewer than two units.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1

for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
4. Press-Type Fittings:

    a. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    b. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

B. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.

1. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
3. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
4. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
5. Press-Type Fittings:

    a. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    b. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

C. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.

D. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

2.2 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

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

C. Threaded-Joint Tape: PTFE.

D. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.

B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

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

a. Amico Corporation.
b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Bronze Check Valves: In-line pattern.

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

a. Allied Healthcare Products, Inc.; Chemetron Div.
b. Amico Corporation.
c. BeaconMedaes.
d. Squire-Cogswell/Aeros Instruments, Inc.

2. Pressure Rating: 300 psig minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

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

a. Amico Corporation.
b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. Vacuum Gage: Manufacturer installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

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

a. Amico Corporation.
b. BeaconMedaes.

2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

G. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.

2.4 MEDICAL VACUUM SERVICE CONNECTIONS

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

1. Amico Corporation.
2. BeaconMedaes.

B. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:

a. Steel outlet box for recessed mounting and concealed piping.
b. Brass-body inlet block.
c. Seals that will prevent vacuum leakage.
d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:

a. Brass housing with primary check valve.
b. Seals that will prevent vacuum leakage.
c. Cover plate with gas-service label.

3. Quick-Coupler Service Connections: Suction inlets for medical vacuum and WAGD evacuation service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
4. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

a. Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.

b. WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.

5. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
6. Cover Plates: One piece, anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL VACUUM PIPING ALARM SYSTEMS

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

1. Amico Corporation.
2. BeaconMedaes.

B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Vacuum Operating Range: 0- to 30-in. Hg.

E. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting: Recessed installation.
2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

F. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.

1. Include alarm signals when the following conditions exist:

a. Medical Vacuum: Vacuum drops below 12-in. Hg and backup vacuum pump is in operation.
b. WAGD Evacuation: Vacuum drops below 12-in. Hg.
c. Dental Vacuum: Vacuum drops below 6-in. Hg and backup vacuum producer is in operation.
d. Medical Laboratory Vacuum: Vacuum drops below 10-in. Hg.

G. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

1. Include alarm signals when the following conditions exist:

a. Medical Vacuum: Vacuum drops below 12-in. Hg.
b. WAGD Evacuation: Vacuum drops below 12-in. Hg.

H. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

1. Include alarm signals when the following condition exists:

a. Medical Vacuum: Vacuum drops below 12-in. Hg.

I. Dental Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

1. Include alarm signals when the following conditions exist:

a. Dental Vacuum: Vacuum drops below 6-in. Hg and backup vacuum producer is in operation.

J. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

1. Include alarm signals when the following condition exists:

a. Medical Vacuum: Vacuum drops below 12-in. Hg.

2.6 FLEXIBLE PIPE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Hyspan Precision Products, Inc.
4. Metraflex, Inc.
5. Universal Metal Hose; a Hyspan Co.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: 200 psig minimum.
2. End Connections: Threaded copper pipe or plain-end copper tube.

2.7 SLEEVES

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

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.10 NITROGEN

A. Description: Comply with USP 28 – NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.

    a. Scrub to ensure complete cleaning.
    b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Connect new copper tubing to existing tubing with memory-metal couplings.

B. Medical Vacuum Piping: Use one of the following piping materials for each size range:

1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 4 and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.
3. NPS 5 to NPS 8: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. WAGD Evacuation Piping: Use one of the following piping materials for each size range:

1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 4 and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.
3. NPS 5 to NPS 8: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Dental Vacuum Piping: Use one of the following piping materials for each size range:

1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed or soldered joints.
2. NPS 4 and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.
3. NPS 5 to NPS 8: Type L, copper medical gas tube; wrought-copper fittings; and brazed or soldered joints.

E. Medical Laboratory Vacuum Piping: Use one of the following piping materials for each size range:

1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 4 and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.
3. NPS 5 to NPS 8: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

F. Drain Piping: Use one of the following piping materials:

1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Comply with ASSE Standard #6010 for installation of vacuum piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install vacuum and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.

I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.

O. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

P. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.

S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

T. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE APPLICATIONS

A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.5 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from vacuum equipment and specialties.

B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.

F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.

G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.6 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

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

D. Threaded Joints: Apply appropriate tape to external pipe threads.

E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

G. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by procedure manufacture.

H. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
2. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

I. Pressure-Sealed Joints: Join copper tube and copper and copper-alloy fittings with tools recommended by fitting manufacturer.

J. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.

B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.

C. Install medical vacuum piping system area and master alarm panels where indicated.

D. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

3.8 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe, stack sleeve fittings.

1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than NPS 6.
2. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum board partitions.
3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend

sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

a. Seal space outside of sleeve fittings with grout.

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

3.9 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece or split casting, cast brass with polished chrome-plated finish.
d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with rough-brass finish stamped steel with set screw or spring clips.
e. Bare Piping in Equipment Rooms: One piece, cast brass/stamped steel with set screw or spring clips.
f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

2. Existing Piping:

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

3.10 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 4: 16 feet with 1/2-inch rod.
11. NPS 5: 18 feet with 1/2-inch rod.
12. NPS 6: 20 feet with 5/8-inch rod.
13. NPS 8: 23 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Vacuum: Black letters on white background.
2. WAGD: White letters on violet background.
3. Dental Vacuum: Black boxed letters on white-and-black diagonal stripe background.
4. Medical Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

3.12 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities.

B. Perform tests and inspections of vacuum piping in nonmedical laboratory facilities.

C. Tests and Inspections:

1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

    a. Test Pressure for Copper Tubing: 100 psig.

2. Repair leaks and retest until no leaks exist.
3. Inspect filters for proper operation.

D. Prepare test reports.

3.13 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

    a. Initial blow down.
    b. Initial pressure test.
    c. Cross-connection test.
    d. Piping purge test.
    e. Standing pressure test for vacuum systems.
    f. Repair leaks and retest until no leaks exist.

3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:

    a. Standing pressure test.
    b. Individual-pressurization or pressure-differential cross-connection test.
    c. Valve test.
    d. Master and area alarm tests.
    e. Piping purge test.
    f. Final tie-in test.
    g. Operational vacuum test.
    h. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

a. Inspections performed.
b. Procedures, materials, and gases used.
c. Test methods used.
d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.14 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 63 13

GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig.
2. Helium piping, designated "medical helium" operating at 50 to 55 psig.
3. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig.
4. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig.
5. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.
6. Other specialty gas piping and specialties as designated on drawings operating at 50 to 55 psig.

B. Owner-Furnished Material:

1. Medical gas manifolds.
2. Ceiling columns.
3. Bulk gas storage tanks.
4. Owner will furnish gases for medical gas concentration testing specified in this Section.

C. Related Sections include the following:

1. Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities" for compressed-air piping systems for laboratory and healthcare facilities.
2. Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities" for vacuum piping systems for laboratory and healthcare facilities.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. D.I.S.S.: Diameter-index safety system.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Medical gas piping systems include nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

E. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Gas manifolds and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 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. Product Data: For the following:

1. Tubes and fittings.
2. Valves and valve boxes.
3. Medical gas service connections.
4. Electrical service connections.
5. Medical nitrogen pressure control panels.
6. Ceiling hose assemblies. Include integral service connections.
7. Gas manifolds.
8. Medical gas alarm system components.
9. Gas cylinder storage racks.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer.

E. Brazing certificates.

F. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

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

G. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. NFPA Compliance:

1. Comply with NFPA 50, "Bulk Oxygen Systems at Consumer Sites," for bulk oxygen storage tanks.
2. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.

G. CGA Compliance: Comply with CGA G-8.1, "Nitrous Oxide Systems at Consumer Sites," for bulk nitrous oxide storage tanks.

H. UL Compliance:

1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
2. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Medical Gas Service(s): Do not interrupt medical gas 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 Architect no fewer than seven days in advance of proposed interruption of medical gas service(s).
2. Do not proceed with interruption of medical gas service(s) without Architect's written permission.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate medical gas service connections with other service connections. Compressed-air service connections are specified in Division 22 Sections "Compressed-Air Piping for Laboratory and Healthcare Facilities" and "Vacuum Piping for Laboratory and Healthcare Facilities."

1.9 EXTRA MATERIALS

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

1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets.

    a. Medical Air: Equal to ten percent of amount installed, but no fewer than two units.
    b. Medical Oxygen: Equal to ten percent of amount installed, but no fewer than two units.
    c. Medical Vacuum: Equal to ten percent of amount installed, but no fewer than two units.

2. D.I.S.S. Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets complying with CGA V-5.

    a. Instrument Air D.I.S.S. No. 1160: Equal to ten percent of amount installed, but no fewer than two units.
    b. Medical Air D.I.S.S. No. 1160: Equal to ten percent of amount installed, but no fewer than two units.
    c. Medical Oxygen D.I.S.S. No. 1240: Equal to ten percent of amount installed, but no fewer than two units.
    d. Medical Vacuum D.I.S.S. No. 1220: Equal to ten percent of amount installed, but no fewer than two units.

3. Vacuum Bottle Brackets: Equal to ten percent of amount installed, but no fewer than two units.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
4. Press-Type Fittings:

    a. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    b. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

5. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

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

    a. Amico Corporation.
    b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.

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

    a. Amico Corporation.
    b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

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

    a. Amico Corporation.
    b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. Pressure Gage: Manufacturer-installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

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

    a. Amico Corporation.
    b. BeaconMedaes.

2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.4 MEDICAL GAS PIPING ALARM SYSTEMS

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

1. Amico Corporation.
2. BeaconMedaes.

B. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Low-Pressure Operating Range: 0- to 100-psig.
2. High-Pressure Operating Range: Up to 250-psig.

E. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting: Recessed installation.
2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

F. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.

1. Include alarm signals when the following conditions exist:

a. Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.5 SLEEVES

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

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.

    a. Scrub to ensure complete cleaning.
    b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Comply with ASSE Standard #6010 for installation of medical gas piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

L. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

M. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

N. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

O. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

3.4 VALVE INSTALLATION

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.5 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

D. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.

E. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.6 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

A. Install medical gas alarm system components in locations required by and according to NFPA 99.

B. Install medical gas area and master alarm panels where indicated.

3.7 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe, galvanized-steel sheet, stack sleeve fittings.

1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than NPS 6.
2. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum board partitions.
3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

    a. Seal space outside of sleeve fittings with grout.

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

3.8 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
    b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
    c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece or split casting, cast brass with polished chrome-plated finish.
    d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with rough-brass finish/stamped steel with set screw or spring clips.
    e. Bare Piping in Equipment Rooms: One piece, cast brass/stamped steel with set screw or spring clips.
    f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

2. Existing Piping:

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

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 4: 16 feet with 1/2-inch rod.
11. NPS 5: 18 feet with 1/2-inch rod.
12. NPS 6: 20 feet with 5/8-inch rod.
13. NPS 8: 23 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.10 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Oxygen: White letters on green background or green letters on white background.

3.11 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.

B. Perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.

C. Tests and Inspections:

1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect specialty gas regulators for proper operation.

3.12 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

    a. Initial blow down.
    b. Initial pressure test.
    c. Cross-connection test.
    d. Piping purge test.
    e. Standing pressure test for positive pressure medical gas piping.
    f. Standing pressure test for vacuum systems.
    g. Repair leaks and retest until no leaks exist.

3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:

    a. Standing pressure test.
    b. Individual-pressurization or pressure-differential cross-connection test.
    c. Valve test.
    d. Master and area alarm tests.
    e. Piping purge test.
    f. Piping particulate test.
    g. Piping purity test.
    h. Final tie-in test.
    i. Operational pressure test.
    j. Medical gas concentration test.
    k. Medical air purity test.
    l. Verify correct labeling of equipment and components.
    m. Verify the following source equipment:

        1) Medical gas supply sources.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

    a. Inspections performed.
    b. Procedures, materials, and gases used.
    c. Test methods used.
    d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.13 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Coordination drawings.
9. Project Record Drawings.
10. TMS Asset Forms
11. Trenching, excavating and backfilling.
12. HVAC demolition.
13. Equipment installation requirements common to equipment sections.
14. Painting and finishing.
15. Concrete bases.
16. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Any additional costs as a result of these modifications shall be borne by the contractor. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of HVAC systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Sequence, coordinate, and integrate removal of existing equipment and material as required to maintain services for existing building and for portions of remodeled areas at all times.

1.8 SCHEDULING AND PHASING

A. All HVAC work shall be scheduled to meet project completion date. HVAC work shall be phased for projects requiring phasing of work. Install additional fittings, valves, caps, and dampers as required to support phasing. Refer to phasing schedule on drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

2.4 TRANSITION FITTINGS

A. Acceptable Manufacturers:

1. Eslon Thermoplastics.
2. NIBCO, Inc.
3. Thompson Plastics, Inc.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Acceptable Manufacturers:

1. Capitol Manufacturing Co.
2. Capico Inc.
3. Epco Sales, Inc.
4. Hart Industries, International, Inc.
5. Watts Industries, Inc.; Water Products Div.
6. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Acceptable Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM or NBR 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. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated or Rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.10 COORDINATION DRAWINGS

A. The contractor shall prepare CAD generated overall coordination drawings (min ¼" scale) to coordinate HVAC systems installation with other trades. Following systems/items shall be indicated and co-coordinated, but not limited to, with each other based on input from installers of these systems:

1. Ceiling layout.
2. Sheet metal ductwork including locations of boxes, diffusers, grilles/registers, duct risers, fire/smoke dampers, etc.
3. HVAC piping routing including locations of valves, expansion loops, risers, etc.
4. Fire suppression piping mains, sprinkler heads, flow switches, etc.
5. Plumbing piping routing including locations of valves, drops to fixtures, risers, etc.
6. Medical gas piping routing including locations of zone valves, drops to outlets/headwalls, etc.
7. Electrical systems including locations of light fixtures, routing of main feeders/conduits larger than 3" dia., routing of cable tray, etc.

B. Contractor shall obtain information of other systems from General Contractor, Electrical Contractor, Fire Suppression Contractor, Plumbing Contractor and others as required for incorporation in the coordination drawings.

C. Contractor shall arrange coordination meeting with other contractors, whose systems need coordination, to resolve conflicts.

D. See General Conditions for project coordination drawing requirements.

2.11 PROJECT RECORD DRAWINGS

A. See General Conditions for project record drawings requirements.

2.12 TMS ASSET FORMS

A. The Contractor shall populate and update Owner's TMS Asset forms for all areas renovated. This shall include listing information for all new equipment installed, existing equipment that is reused and deleting equipment removed during construction.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Generally remove piping up to existing mains or valves.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Cap behind walls, chases, shafts or flush with floor. Patch surfaces to match existing adjacent surfaces.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material. Generally remove ducts up to existing mains or shut-off dampers.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping minimum 8 inches above accessible ceilings to allow sufficient space for ceiling panel removal and service access.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

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

2. Existing Piping: Use the following:

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

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

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

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
    b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

        1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

V. Draining and Refilling of Systems: Provide all shutoff valves, drain valves, pipe, fittings, and miscellaneous material required to drain each existing system as required for new work. After new work is completed, tested, and found tight, refill each system as required. Time for shutting down existing system for draining shall be coordinated with all other work and with Owner's representative. Fill glycol system with type and percentage solutions as directed by Owner.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. 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. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete".

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

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

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

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

2.2 MOTOR CHARACTERISTICS

A. Motors ½ HP and Larger: Three phase, unless shown otherwise.

B. Motors Smaller than ½ HP: Single phase, unless shown otherwise.

C. Frequency Rating: 60 Hz/

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

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

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

H. Enclosure: Open drip-proof.

2.3 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

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

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F unless otherwise noted.

I. Code Letter Designation:

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

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

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

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Motors under 100 hp – Provide shaft grounding ring on either the drive end or non-drive end of the motor in accordance with manufacturer's recommendations.
6. Motors 100 hp and above – Provide ceramic bearing or bearing journal on non-drive end of the motor and shaft grounding ring on the opposite end in accordance with manufacturer's recommendations.

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

2.5 SINGLE-PHASE MOTORS

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

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

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

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

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

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 05 16

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal-bellows expansion joints.
2. Expansion compensators.
3. Rubber expansion joints.
4. Flexible-hose expansion joints.
5. Packed slip expansion joints.
6. Flexible ball joints.
7. Pipe bends and loops.
8. Alignment guides and anchors.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide 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. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

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

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

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

1. Adsco Manufacturing, LLC.
2. Expansion Joint Systems, Inc.
3. Flex-Hose Co., Inc.
4. Flexicraft Industries.
5. Hyspan Precision Products, Inc.
6. Metraflex, Inc.
7. Piping Technology & Products, Inc.
8. Senior Flexonics, Inc.; Pathway Division.

B. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.

1. Metal-Bellows Expansion Joints for Copper Piping: Single- or multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.

2. Metal-Bellows Expansion Joints for Stainless-Steel Waterway: Single-ply stainless-steel bellows, stainless-steel-pipe end connections, and steel shroud.
3. Metal-Bellows Expansion Joints for Steel Piping: Single- or multiple-ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.
4. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
5. Configuration: Single- or double-bellows type with base, unless otherwise indicated.
6. End Connections: Flanged.

C. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, antitorque device, and removable end clip for positioning.

1. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
2. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
3. Configuration for Steel Piping: Two-ply stainless-steel bellows and carbon-steel shroud.
4. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
5. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
6. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
7. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.

D. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

1. Arch Type: Single or multiple arches.
2. Spherical Type: Single spheres.

    a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
    b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.
    c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F.

3. Material: Buna-N.
4. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

E. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections.

    a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
    b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

2. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.

a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
c. NPS 8 and Larger: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.

F. Packed Slip Expansion Joints: ASTM F 1007, carbon-steel, packing type designed for repacking under pressure and pressure rated for 250 psig at 400 deg F minimum. Include asbestos-free PTFE packing, compound limit stops, and drip connection if used for steam piping.

1. Configuration: Single- and double-joint class with base, unless otherwise indicated.
2. End Connections: Flanged or weld ends to match piping system.

G. Flexible Ball Joints: Carbon-steel assembly with asbestos-free composition packing, designed for 360-degree rotation and angular deflection, and 250 psig at 400 deg F minimum pressure rating; complying with ASME Boiler and Pressure Vessel Code: Section II, "Materials," and with ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.

1. Angular Deflection for NPS 6 and Smaller: 30-degree minimum.
2. Angular Deflection for NPS 8 and Larger: 15-degree minimum.
3. End Connections for NPS 2 and Smaller: Threaded.
4. End Connections for NPS 2-1/2 and Larger: Flanged.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

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

a. Adsco Manufacturing, LLC.
b. Flex-Hose Co., Inc.
c. Flexicraft Industries.
d. Hyspan Precision Products, Inc.
e. Metraflex, Inc.
f. Piping Technology & Products, Inc.
g. Senior Flexonics, Inc.; Pathway Division.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: Zinc-coated steel.
3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, 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 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least four pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Flowmeters.
5. Thermal-energy meters.

B. Related Sections:

1. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.
2. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers, gages, flowmeters and thermal-energy meters indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer, gage, flowmeter and thermal-energy meter, signed by product manufacturer.

D. Operation and Maintenance Data: For flowmeters and thermal-energy meters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

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

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Marsh Bellofram.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Dry or Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

F. Pointer: Red or other dark-color metal.

G. Window: Glass or plastic.

H. Ring: Metal.

I. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

J. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

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

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Marsh Bellofram.
4. Palmer - Wahl Instruments Inc.
5. Tel-Tru Manufacturing Company.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

F. Pointer: Red or other dark-color metal.

G. Window: Glass or plastic.

H. Ring: Metal.

I. Connector: Bottom or Back union type.

J. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 BIMETALLIC-ACTUATED DIAL THERMOMETERS

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

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Eugene Ernst Products Co.
3. Marsh Bellofram.
4. Palmer - Wahl Instruments Inc.
5. Tel-Tru Manufacturing Company.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

C. Case: Dry or Liquid-filled type, stainless steel with 5-inch diameter.

D. Element: Bimetal coil.

E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

F. Pointer: Red or other dark-color metal.

G. Window: Glass or plastic.

H. Ring: Stainless steel.

I. Connector: Adjustable angle type.

J. Stem: Metal, for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.4 THERMOWELLS

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

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Marsh Bellofram.
5. Palmer - Wahl Instruments Inc.
6. Tel-Tru Manufacturing Company.
7. Trerice, H. O. Co.
8. Weiss Instruments, Inc.
9. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.5 PRESSURE GAGES

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

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Marsh Bellofram.
5. Palmer - Wahl Instruments Inc.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry or Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass or plastic.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Remote-Mounting, Dial-Type Pressure Gages: ASME B40.100, indicating-dial type.

1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass or plastic.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

D. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.6 TEST PLUGS

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

1. Flow Design, Inc.
2. National Meter, Inc.
3. Peterson Equipment Co., Inc.
4. Trerice, H. O. Co.
5. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

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

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.

3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

2.7 FLOW METERS

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

1. ABB, Inc.; ABB Instrumentation.
2. Armstrong Pumps, Inc.
3. Badger Meter, Inc.; Industrial Div.
4. Bailey-Fischer & Porter Co.
5. Bell & Gossett; ITT Industries.
6. Hyspan Precision Products, Inc.
7. Meriam Instruments Div.; Scott Fetzer Co.

B. Wafer-Orifice Flowmeters:

1. Description: Differential-pressure-design orifice insert for installation between pipe flanges; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.
2. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
3. Pressure Rating: 300 psig.
4. Temperature Rating: 250 deg F.
5. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
6. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
    a. Scale: Gallons per minute.
    b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.
7. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.
    a. Scale: Gallons per minute.
    b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

C. Operating Instructions: Include complete instructions with each flowmeter.

D. Venturi Flowmeters:

1. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.
2. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data.
3. Pressure Rating: 250 psig.
4. Temperature Rating: 250 deg F.

5. End Connections for NPS 2 and Smaller: Threaded.
6. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
7. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
8. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

    a. Scale: Gallons per minute.
    b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.

9. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.

    a. Scale: Gallons per minute.
    b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

10. Operating Instructions: Include complete instructions with each flowmeter.

E. Turbine Flowmeters:

1. Description: Insertion type for inserting turbine into piping and measuring flow directly in gallons per minute.
2. Construction: Bronze or stainless-steel body; with plastic turbine or impeller and integral direct-reading scale.
3. Pressure Rating: 150 psig minimum.
4. Temperature Rating: 180 deg F minimum.
5. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.
6. Accuracy: Plus or minus 2-1/2 percent.

F. Vortex-Shedding Flowmeters:

1. Description: Inline type for installing between pipe flanges and measuring flow directly in gallons per minute.
2. Construction: Stainless-steel body; with integral transmitter and direct-reading scale.
3. Pressure Rating: 1000 psig minimum.
4. Temperature Rating: 500 deg F minimum.
5. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.
6. Integral Transformer: For low-voltage power operation.
7. Accuracy: Plus or minus 7/10 percent for liquids and 1-1/4 percent for gases.

2.8 PITOT-TUBE FLOWMETERS

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

1. Dieterich Standard Inc.
2. Meriam Instruments Div.; Scott Fetzer Co.
3. Preso Meters Corporation.
4. Taco, Inc.
5. Veris Industries.

B. Description: Insertion-type, differential-pressure design for inserting probe into piping and measuring flow directly in gallons per minute.

C. Construction: Stainless-steel probe of length to span inside of pipe; with integral transmitter and direct-reading scale.

D. Pressure Rating: 150 psig minimum.

E. Temperature Rating: 250 deg F minimum.

F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.

G. Integral Transformer: For low-voltage power connection.

H. Accuracy: Plus or minus 1 percent for liquids and gases.

2.9 FLOW INDICATORS

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

1. Brooks Instrument Div.; Emerson Electric Co.
2. Dwyer Instruments, Inc.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. OPW Engineered Systems; Dover Corp.
6. Penberthy, Inc.

B. Description: Instrument for installation in piping systems for visual verification of flow.

C. Construction: Bronze or stainless-steel body; with sight glass and plastic pelton-wheel indicator, and threaded or flanged ends.

D. Pressure Rating: 125 psig.

E. Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.10 INSERTION-TURBINE, THERMAL-ENERGY METER SYSTEMS

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

1. Data Industrial Corp.
2. ONICON Incorporated.
3. Thermo Measurement Ltd.

B. Description: Flow sensor, strainer, two temperature sensors, transmitter, meter, and connecting wiring.

C. Flow Sensor: Insertion-type turbine or paddle-wheel element with corrosion-resistant-metal body and transmitter.

1. Pressure Rating: 125 psig.
2. Temperature Range: 40 to 250 deg F.

D. Meter: Solid-state integrating type with integral battery pack.

1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
2. Accuracy: Plus or minus 1 percent.
3. Battery Pack: Five-year lithium battery.

E. Strainer: Full size of main line piping.

2.11 INLINE-TURBINE, THERMAL-ENERGY METER SYSTEMS

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

1. Engineering Measurements Company.
2. Hoffer Flow Controls, Inc.
3. ISTEC Corporation.
4. Thermo Measurement Ltd.
5. Venture Measurement.

B. Description: Flow sensor, strainer, two temperature sensors, transmitter, meter, and connecting wiring.

C. Flow Sensor: Turbine-type water meter with corrosion-resistant-metal body and transmitter.

1. Pressure Rating: 150-psig minimum working-pressure rating.
2. Temperature Range: 40 to 250 deg F.

D. Meter: Solid-state integrating type with integral battery pack.

1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
2. Accuracy: Plus or minus 1 percent.
3. Battery Pack: Five-year lithium battery.

E. Strainer: Full size of main line piping.

2.12 ULTRASONIC, THERMAL-ENERGY METER SYSTEMS

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

1. Controlotron Corporation.
2. Engineering Measurements Company.
3. Mesa Laboratories, Inc.; Nusonics Div.

B. Description: Flow sensor, two temperature sensors, transmitter, meter, and connecting wiring.

C. Flow Sensor: Strap-on or integral ultrasonic type with transmitter.

D. Meter: Solid-state integrating type with integral battery pack.

1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
2. Accuracy: Plus or minus 1 percent.
3. Battery Pack: Five-year lithium battery.

E. Strainer: Full size of main line piping.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each hydronic heat-recovery unit.
6. Inlet and outlet of each thermal storage tank.
7. Outside-air, return-air, and mixed-air ducts.

B. Install direct-mounting, vapor-actuated dial thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each hydronic heat-recovery unit.
6. Inlet and outlet of each thermal storage tank.

C. Install remote-mounting, vapor-actuated dial thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each hydronic heat-recovery unit.
6. Inlet and outlet of each thermal storage tank.

D. Install bimetallic-actuated dial thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each hydronic heat-recovery unit.

6. Inlet and outlet of each thermal storage tank.

E. Install dry or liquid-filled-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.

F. Provide the following temperature ranges for thermometers:

1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
3. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
4. Steam and Condensate: 30 to 300 deg F, with 5-degree scale divisions.
5. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install dry or liquid-filled-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.

C. Install dry or liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

E. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

F. Install remote-mounting pressure gages on panel.

G. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

H. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

I. Install test plugs in tees in piping.

J. Install flow indicators, in accessible positions for easy viewing, in piping systems.

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

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

M. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

N. Install wafer-orifice flowmeter elements between pipe flanges.

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

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

Q. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.

R. Assemble components and install thermal-energy meters.

S. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.4 CONNECTIONS

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

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy-meter transmitters to meters.

3.5 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.

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

END OF SECTION

SECTION 23 05 23

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron, single-flange butterfly valves.
5. Iron, grooved-end butterfly valves.
6. High-performance butterfly valves.
7. Bronze lift check valves.
8. Bronze swing check valves.
9. Iron swing check valves.
10. Iron, grooved-end swing-check valves.
11. Iron, center-guided check valves.
12. Bronze gate valves.
13. Iron gate valves.
14. Bronze globe valves.
15. Iron globe valves.
16. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

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 angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block 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. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

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

1. Crane Co.; Crane Valve Group.
2. Hammond Valve.
3. Milwaukee Valve Company.
4. NIBCO INC.

B. Class 150, Bronze Angle Valves with Bronze Disc:

1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron.

2.3 BRONZE BALL VALVES

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

1. American Valve, Inc.
2. Conbraco Industries, In.; Apollo Valves.
3. Crane Co.; Crane Valve Group; Crane Valves.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

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

1. Conbraco Industries, Inc.; Apollo Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. DeZurik Water Controls.
5. Hammond Valve.
6. Milwaukee Valve Company.
7. NIBCO INC.
8. Spence Strainers International; a division of CIRCOR International, Inc.
9. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM or NBR Seat and Stainless-Steel Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM or NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM or NBR Seat and Stainless-Steel Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM or NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.5 IRON, GROOVED-END BUTTERFLY VALVES

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

1. Crane Co.; Crane Valve Group; Stockham Division.
2. Hammond Valve.
3. Kennedy Valve; a division of McWane, Inc.
4. NIBCO INC.
5. Tyco Fire Products LP; Grinnell Mechanical Products.
6. Victaulic Company.

B. 175 CWP, Iron, Grooved-End Butterfly Valves:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig.
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

C. 300 CWP, Iron, Grooved-End Butterfly Valves:

1. Description:

a. Standard: MSS SP-67, Type I.
b. NPS 8 and Smaller CWP Rating: 300 psig.
c. NPS 10 and Larger CWP Rating: 200 psig.
d. Body Material: Coated, ductile iron.
e. Stem: Two-piece stainless steel.
f. Disc: Coated, ductile iron.
g. Seal: EPDM.

2.6 HIGH-PERFORMANCE BUTTERFLY VALVES

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

1. Bray Controls; a division of Bray International.
2. Crane Co.; Crane Valve Group; Flowseal.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. DeZurik Water Controls.
5. Hammond Valve.
6. Jamesbury; a subsidiary of Metso Automation.
7. Milwaukee Valve Company.
8. NIBCO INC.
9. Tyco Valves & Controls; a unit of Tyco Flow Control.

B. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. Description:

a. Standard: MSS SP-68.
b. CWP Rating: 285 psig at 100 deg F.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

C. Class 300, Single-Flange, High-Performance Butterfly Valves:

1. Description:

a. Standard: MSS SP-68.
b. CWP Rating: 720 psig at 100 deg F.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, or ductile iron.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

2.7 BRONZE LIFT CHECK VALVES

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

1. American Valve, Inc.
2. Crane Co.; Crane Valve Group; Crane Valves.
3. Crane Co.; Crane Valve Group; Jenkins Valves.
4. Crane Co.; Crane Valve Group; Stockham Division.
5. Hammond Valve.

6. Milwaukee Valve Company.
7. NIBCO INC.
8. Powell Valves.
9. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Lift Check Valves with Bronze Disc:

1. 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.
f. Disc: Bronze.

C. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: NBR, PTFE, or TFE.

2.8 BRONZE SWING CHECK VALVES

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

1. American Valve, Inc.
2. Crane Co.; Crane Valve Group; Crane Valves.
3. Crane Co.; Crane Valve Group; Jenkins Valves.
4. Crane Co.; Crane Valve Group; Stockham Division.
5. Hammond Valve.
6. Milwaukee Valve Company.
7. NIBCO INC.
8. Powell Valves.
9. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. 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.
f. Disc: Bronze.

2.9 IRON SWING CHECK VALVES

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

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Iron Swing Check Valves with Metal Seats:

1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

C. Class 250, Iron Swing Check Valves with Metal Seats:

1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.10 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

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

a. Anvil International, Inc.
b. Tyco Fire Products LP; Grinnell Mechanical Products.
c. 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.

2.11 IRON, CENTER-GUIDED CHECK VALVES

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

1. Anvil International, Inc.
2. DFT Inc.
3. Hammond Valve.
4. Metraflex, Inc.
5. Milwaukee Valve Company.
6. Mueller Steam Specialty; a division of SPX Corporation.
7. NIBCO INC.
8. Spence Strainers International; a division of CIRCOR International, Inc.
9. Watts Regular Co.; a division of Watts Water Technologies, Inc.

B. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

1. Description:

a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
c. NPS 14 to NPS 24, CWP Rating: 250 psig.
d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
e. Style: Compact wafer.
f. Seat: Bronze.

C. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

1. Description:

a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Material: ASTM A 126, gray iron.
e. Style: Compact wafer, spring loaded.
f. Seat: Bronze.

D. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Description:

a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron.
e. Style: Compact wafer.
f. Seat: EPDM or NBR.

E. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Description:

a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
c. NPS 14 to NPS 24, CWP Rating: 250 psig.
d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
e. Style: Compact wafer.
f. Seat: EPDM or NBR.

F. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Description:

a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Material: ASTM A 126, gray iron.
e. Style: Compact wafer, spring loaded.
f. Seat: EPDM or NBR.

2.12 BRONZE GATE VALVES

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

1. American Valve, Inc.
2. Crane Co.; Crane Valve Group; Crane Valves.
3. Crane Co.; Crane Valve Group; Jenkins Valves.
4. Crane Co.; Crane Valve Group; Stockham Division.
5. Hammond Valve.
6. Milwaukee Valve Company.
7. NIBCO INC.
8. Powell Valves.
9. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 150, NRS Bronze Gate Valves:

1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

C. Class 150, RS Bronze Gate Valves:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.13 IRON GATE VALVES

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

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, NRS, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.

C. Class 125, OS&Y, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.

D. Class 250, NRS, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.

E. Class 250, OS&Y, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.

2.14 BRONZE GLOBE VALVES

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

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Stockham Division.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO INC.
6. Powell Valves.
7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Bronze Globe Valves with Bronze Disc:

1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron.

C. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.

c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

D. Class 150, Bronze Globe Valves with Nonmetallic Disc:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.15 IRON GLOBE VALVES

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

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Iron Globe Valves:

1. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

C. Class 250, Iron Globe Valves:

1. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 500 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.

e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

2.16 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for valves 6 inches and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service except Steam: Globe or angle, ball, or butterfly valves.
4. Throttling Service, Steam: Globe or butterfly valves.
5. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.

B. Pressure ratings for valves shall not be less than as required for system pressures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

D. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 and Larger: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 and Larger: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
5. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

E. Ball valves used in steam or steam condensate service shall be rated for steam application.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze or nonmetallic disc.
3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM or NBR seat, ductile-iron or stainless-steel disc.
2. Iron, Single-Flange Butterfly Valves, NPS 14 and Larger: 150 CWP, EPDM or NBR seat, ductile-iron or stainless-steel disc.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 or 300 CWP.
4. High-Performance Butterfly Valves: Class 150 or Class 300, single flange.
5. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
6. Iron, Grooved-End Check Valves, NPS 3 to NPS 12: 300 CWP.
7. Iron, Center-Guided Check Valves: Class 125 or Class 150 or Class 250, compact-wafer, metal or resilient seat.
8. Iron Gate Valves: Class 125 or Class 250, NRS or OS&Y.
9. Iron Globe Valves: Class 125 or Class 250.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze or nonmetallic disc.
3. Ball Valves: Two piece, full port, stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM or NBR seat, stainless-steel disc.
2. Iron, Single-Flange Butterfly Valves, NPS 14 and Larger: 150 CWP, EPDM or NBR seat, stainless-steel disc.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 or 300 CWP.
4. High-Performance Butterfly Valves: Class 150 or Class 300, single flange.
5. Iron Swing Check Valves: Class 125 or Class 250, metal or nonmetallic-to-metal seats.
6. Iron, Grooved-End Check Valves, NPS 3 to NPS 12: 300 CWP.
7. Iron, Center-Guided Check Valves, NPS 2-1/2 to NPS 24: Class 150 or Class 250, metal or resilient seat.
8. Iron Gate Valves: Class 125 or Class 250, NRS or OS&Y.
9. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125 or Class 250.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze or nonmetallic disc.

3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM or NBR seat, ductile-iron or stainless-steel disc.
2. Iron, Single-Flange Butterfly Valves, NPS 14 and Larger: 150 CWP, EPDM or NBR seat, ductile-iron or stainless-steel disc.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 or 300 CWP.
4. High-Performance Butterfly Valves: Class 150 or Class 300, single flange.
5. Iron Swing Check Valves: Class 250, metal seats.
6. Iron, Grooved-End Check Valves, NPS 3 to NPS 12: 300 CWP.
7. Iron, Center-Guided Check Valves: Class 150 or Class 250, compact-wafer, metal or resilient seat.
8. Iron Gate Valves: Class 125 or Class 250, NRS or OS&Y.
9. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125 or Class 250.

3.8 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Bronze Angle Valves: Class 150, bronze disc.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. High-Performance Butterfly Valves: Class 150 or Class 300, single flange.
2. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
3. Iron Gate Valves: Class 125 or Class 250, NRS or OS&Y.
4. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125 or Class 250.

3.9 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller:

1. Bronze Angle Valves: Class 150, bronze or nonmetallic disc.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves Class 150, bronze disc.
4. Globe Valves 150, bronze, bronze disc.

B. Pipe Sizes NPS 2-1/2 and Larger:

1. High-Performance Butterfly Valves: Class 150 or Class 300, single flange.
2. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
3. Iron Gate Valves: Class 125 or Class 250, NRS or OS&Y.
4. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125 or Class 250.

3.10 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Angle Valves: Class 150, bronze or nonmetallic disc.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze or nonmetallic disc.
4. Bronze Globe Valves: Class 150, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. High-Performance Butterfly Valves: Class 150 or Class 300, single flange.
2. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
3. Iron Gate Valves: Class 125 or Class 250, NRS or OS&Y.
4. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125 or Class 250.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:

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

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
5. Division 23 Section(s) “Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

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

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.

B. Welding certificates.

1.6 QUALITY ASSURANCE

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

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Acceptable Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. Empire Industries, Inc.
4. Globe Pipe Hanger Products, Inc.
5. Grinnell Corp.
6. GS Metals Corp.
7. National Pipe Hanger Corporation.
8. Piping Technology & Products, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of polyurethane or stainless steel.

1. Acceptable Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Champion Fiberglass, Inc.
c. Cope, T. J., Inc.; Tyco International, Ltd.
d. Unistrut Corp.; Tyco International, Ltd.

B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.

1. Acceptable Manufacturers:

a. Plasti-Fab, Inc.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Acceptable Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. GS Metals Corp.
3. Power-Strut Div.; Tyco International, Ltd.

4. Thomas & Betts Corporation.
5. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

B. Acceptable Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Champion Fiberglass, Inc.
3. Cope, T. J., Inc.; Tyco International Ltd.

2.7 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Acceptable Manufacturers:

1. Carpenter & Paterson, Inc.
2. PHS Industries, Inc.
3. Pipe Shields, Inc.
4. Rilco Manufacturing Company, Inc.
5. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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

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

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

2.8 FASTENER SYSTEMS

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

1. Acceptable Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.

2.9 PIPE STAND FABRICATION

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

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Acceptable Manufacturers:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Base: Plastic or Stainless steel.
2. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
3. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Bases: One or more plastic.
2. Vertical Members: Two or more protective-coated-steel channels.
3. Horizontal Member: Protective-coated-steel channel.
4. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.10 EQUIPMENT SUPPORTS

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

2.11 MISCELLANEOUS MATERIALS

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

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

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

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

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

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

F. 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 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, 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 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or 2-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.
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 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 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
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 might occur and vertical adjustment is not necessary.
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 might be required in addition to expansion and contraction.

G. 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 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. 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.

J. 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.

K. 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 absorb 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 absorb 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 absorb 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.

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

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

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

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

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

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. 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. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

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

G. Fastener System Installation:

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

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Install hangers and supports complete with necessary 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 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 so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

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 according to ASME B31.1 for power piping and 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 inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation 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 smooth bearing surface.

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

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

END OF SECTION

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Freestanding and restrained spring isolators.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Restrained vibration isolation roof-curb rails.
11. Seismic snubbers.
12. Restraining braces and cables.
13. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring

deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

5. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
6. Seismic- and Wind-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

B. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall be preapproved by agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Pads Type A.1: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Mounts Type A.2: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators Type B.1: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators Type B.2: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Housed Spring Mounts Type B.3: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

G. Elastomeric Hangers Type B.4: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

H. Spring Hangers Type B.5: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

I. Spring Hangers with Vertical-Limit Stop Type B.6: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Thrust Limits – Type C.1: Combination coil spring and elastomeric insert with spring and insert in compression with a load stop. Include rod and angle-iron brackets for attaching to equipment.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of ¼-inch movement at start and stop.

K. Pipe Riser Resilient Support - Type D.1: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Thybar Corporation.
5. Vibration Eliminator Co., Inc.
6. Vibration Isolation.
7. Vibration Mountings & Controls, Inc.

B. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or wind restraint.

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

a. Resilient Material: Oil- and water-resistant standard neoprene or natural rubber.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Steel Base – Type E.1: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base – Type E.2: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.4 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. Cooper B-Line, Inc.; a division of Cooper Industries.
3. Hilti, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by authorities having jurisdiction providing required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 VIBRATION ISOLATOR AND SEISMIC-RESTRAINT SCHEDULE FOR SLAB ON GRADE LOCATED EQUIPMENT

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Centrifugal fans	Floor Floor	Up to 60 HP 75 HP and above	E.1 E.1	A.2 B.1	0.25” 0.75”
Inline fans	Floor Suspended	Up to 40 HP All sizes	E.1 --	A.2 B.5	0.25” 0.75”
Utility sets	Floor/Roof Suspended	All sizes All sizes	-- E.1	A.2 B.4	0.25” 0.75”

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Air Handling units	Floor Floor Suspended	Up to 5" SP Above 5" SP All sizes	-- -- --	A.1 A.1 B.5	0.25" 0.25 0.75"
Centrifugal Chillers Absorption Chillers Reciprocating Chillers	Floor Floor Floor	All sizes All sizes All sizes	-- -- --	A.1 A.1 A.1	0.25" 0.25" 0.25"
Centrifugal Pumps	Floor Floor Suspended	Up to 50 HP Above 50 HP All sizes	E.1 E.2 --	A.2 B.1 B.5	0.25" 0.75" 0.25"
Boilers (steam or HW)	Floor	All sizes	--	A.2	0.25"
Cooling Towers with Centrifugal Fans	Floor	All sizes	--	A.2	0.25"
Cooling Tower with Propeller Fans	Floor	All sizes	--	A.2	0.25"
Air Cooled Condensing Units	Floor Floor	Up to 20 HP 25 Hp and above	-- --	A.1 A.2	0.25" 0.50"
Air Cooled Chillers	Floor Floor	Up to 20 HP 25 HP and above	-- --	A.1 A.2	0.25" 0.50"
Air Compressors	Floor	All sizes	E.1	B.1	1.0"
Piping – Horizontal	Suspended	All sizes	-	B.4	0.25"
Piping – Vertical	Floor	All sizes	--	D.1	0.25"

Notes:
1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.
2. Provide C.1 type (thrust limits) isolators for all fans, air handling units rated for more than 5" total static pressure.
3. Isolators indicated for horizontal piping is only for three (3) hangers on discharge/outlet and three (3) hangers on suction/inlet pipes for pumps, air compressors, vacuum pumps, and equipment mounted on type "B" isolators. Remaining piping does not require isolation.
4. Fans within air handling units, equipped with internal vibration isolators, shall not require isolation for fans as indicated in table above.

3.8 VIBRATION ISOLATOR AND SEISMIC – RESTRAINT SCHEDULE FOR EQUIPMENT LOCATED ABOVE GRADE

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Centrifugal Fans	Floor Floor	Up to 40 HP 50HP and above	E.1 E.2	B.1 B.1	2.0" 2.0"
Inline Fans	Floor Suspended	Up to 40 HP All sizes	E.1 --	B.1 B.6	1.0" 1.0"
Utility Sets	Floor/Roof Suspended	All sizes All sizes	-- E.1	B.1 B.4	0.75" 0.75"
Air Handling Units	Floor Suspended Roof Top	All sizes All sizes All sizes	-- -- --	B.1 B.6 Roof curb rails	1.0" 1.0" 1.0"

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Centrifugal Chillers Absorption Chillers Reciprocating Chiller	Floor Floor Floor	All sizes All sizes All sizes	-- -- --	B.2 B.2 B.2	0.75” 0.75” 0.75”
Centrifugal Pumps	Floor Suspended	All sizes All sizes	E.2 --	B.1 B.5	1” 0.25”
Boilers (steam or HW)	Floor	All sizes	--	A.2	0.25”
Cooling Towers with Centrifugal Fans	Roof	All sizes	E.1	B.2	1.0”
Cooling Towers with Propeller Fans	Roof	All sizes	E.1	B.2	1.0”
Air Cooled Condensing Units	Roof Roof	Up to 20 HP 25 HP and above	-- --	A.1 B.2	0.25” 0.75”
Air Cooled Condensers	Roof	All sizes	--	A.1	0.25”
Air Cooled Chillers	Roof Roof	Up to 20 HP 25 HP and above	-- --	A.1 B.2	0.25” 1.0”
Air Compressors	Floor	All sizes	E.2	E.2	1.0”
Piping – Horizontal	Suspended	All sizes	--	B.4	0.25”
Piping – Vertical	Floor	All sizes	--	D.1	0.25”

Notes:
1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.
2. Provide C.1 type (thrust limits) isolators for all fans, air handling units rated for more than 5” total static pressure.
3. Isolators indicated for horizontal piping is only for three (3) hangers on discharge/outlet and three (3) hangers on suction/inlet pipes for pumps, air compressors, vacuum pumps, and equipment mounted on type “B” isolators. Remaining piping does not require isolation.
4. Fans within air handling units, equipped with internal vibration isolators, shall not require isolation for fans as indicated in table above.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.
8. Ceiling Grid Labels

1.3 SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/2 inch and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
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: 1/2 inch and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

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

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

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

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

F. Minimum Letter Size: 1/2 inch and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

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

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

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

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

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

F. Minimum Letter Size: 1/2 inch and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

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

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches.
2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

2.8 CEILING GRID LABELS

A. Self-Adhesive Vinyl Labels for valves, fire dampers, fire/smoke dampers, controls and equipment: Minimum ½" Preprinted, flexible label to match Owner's standards. Color as directed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment, within mechanical rooms, boiler rooms, chiller rooms, etc.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. In general follow Pipe Label Color Schedule as shown below, unless the Owner has different schedule standards in which case the Owner's schedule shall be followed:

1. Chilled-Water Piping:

   a. Background Color: Blue.
   b. Letter Color: White.

2. Condenser-Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3. Heating Water Piping:

   a. Background Color: Orange.
   b. Letter Color: White.

4. Refrigerant Piping:

   a. Background Color: Blue.
   b. Letter Color: White.

5. Low-Pressure Steam Piping:

   a. Background Color: Yellow.
   b. Letter Color: White.

6. High-Pressure Steam Piping:

   a. Background Color: Yellow.
   b. Letter Color: White.

7. Steam Condensate Piping:

   a. Background Color: Yellow.
   b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated or self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

   1. Blue: For cold-air supply ducts.
   2. Yellow: For hot-air supply ducts.
   3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

Reduce intervals to 25 feet in areas of congested piping and equipment, within mechanical rooms, boiler rooms, chiller rooms, etc.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Chilled Water: 1-1/2 inches, round.
   b. Condenser Water: 1-1/2 inches, round.
   c. Refrigerant: 1-1/2 inches, round.
   d. Hot Water: 1-1/2 inches, round.
   e. Gas: 1-1/2 inches, round.
   f. Low-Pressure Steam: 1-1/2 inches, round.
   g. High-Pressure Steam: 1-1/2 inches, round.
   h. Steam Condensate: 1-1/2 inches, round.

2. Valve-Tag Color:

   a. Chilled Water: Natural.
   b. Condenser Water: Natural.
   c. Refrigerant: Natural.
   d. Hot Water: Natural.
   e. Gas: Natural.
   f. Low-Pressure Steam: Natural.
   g. High-Pressure Steam: Natural.
   h. Steam Condensate: Natural.

3. Letter Color:

   a. Chilled Water: Black.
   b. Condenser Water: Black.
   c. Refrigerant: Black.
   d. Hot Water: Black.
   e. Gas: Black.
   f. Low-Pressure Steam: Black.
   g. High-Pressure Steam: Black.
   h. Steam Condensate: Black.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 CEILING GRID LABELS

A. Install ceiling grid labels for all equipment located above ceilings such as HVAC valves, fire and fire/smoke dampers, VAV boxes, air valves, controls and miscellaneous equipment. Color of labels shall match owner's standards.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Balancing Air Systems:

a. Constant-volume air systems.
b. Dual-duct systems.
c. Variable-air-volume systems.
d. Multizone systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.
b. Variable-flow hydronic systems.
c. Primary-secondary hydronic systems.

3. Duct leak testing.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with Architect, Owner, Construction Manager, Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts/Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in

AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or ASHRAE 111 or NEBB's

"Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect or Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect or Commissioning Authority and comply with requirements in Division 23 Section "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.10 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.

5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR DUCT SYSTEM LEAK TESTING

A. Before testing ducts for leaks, observe the ductwork to verify completeness of installation and caps provided at end of sections to seal. Duct systems can be leak tested in sections if phasing or construction schedule prevents it to test entire system.

B. All supply air ducts and sections from air handling units to inlet of boxes shall be leak tested. All return air ducts from return air grilles to return/relief air fan shall be leak tested. Ten percent (10%) of supply air ducts downstream of boxes, but not less than five systems, shall be leak tested. Two exhaust air duct systems shall be leak tested.

C. Tests shall be conducted at 150% of static pressures, but not more than 6” wg, as identified in static pressure class.

D. Provide blower, measuring instruments and other accessories as required to conduct leak tests. Each section or system shall be maintained at test pressure for minimum 30 minutes.

E. Duct system leakage shall not exceed 5% of design air flow. If system is tested in sections, than total leakage of all sections shall not exceed 5% of design air flow.

F. Record tests results and deficiencies for each section of system and submit to Architect or Commissioning Authority for review.

G. Coordinate duct leak testing with contractor.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.16 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 5 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.17 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems'

balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

a. Settings for outdoor-, return-, and exhaust-air dampers.
b. Conditions of filters.
c. Cooling coil, wet- and dry-bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.

f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.

i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.19 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets, but not less than six.
b. Measure water flow of at least 5 percent of terminals, but not less than two.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect or Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect or Commissioning Authority.
3. Architect or Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 00
HVAC 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:

1. Insulation Materials:

    a. Calcium silicate.
    b. Cellular glass.
    c. Flexible elastomeric.
    d. Mineral fiber.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Lagging adhesives.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied fabric-reinforcing mesh.
10. Field-applied cloths.
11. Field-applied jackets.
12. Tapes.
13. Securements.
14. Corner angles.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.
4. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.
5. Division 33 Section "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

1.4 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting 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 and inspecting agency.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

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

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork 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.

1.7 SCHEDULING

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

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 Part 3 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: Inorganic, non-combustible, asbestos free high temperature with high structural strength.

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

    a. Industrial Insulation Group.
    b. Owens Corning Fiberglass Corp.
    c. Pabco.
    d. Schuller International Inc.

2. Preformed Pipe Sections: 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.
3. 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.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in performing insulation to cover valves, elbows, tees, and flanges.
5. Density: 14.5 lbs./cu. ft.
6. Thermal Conductivity: Not exceeding 0.45 BTU – in/hour sq. ft. ^{o}F at 300^{o}F mean temperature.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

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

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. NOMACO Insulation.

2. Thermal Conductivity: Not exceeding 0.25 BTU-in/hour ^{o}F at 75^{o}F mean temperature.

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 III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

    a. CertainTeed Corp.
    b. Johns Manville.
    c. Knauf Insulation.
    d. Manson Insulation Inc.
    e. Owens Corning Fiberglas Corp.

2. Density: 1.9 lbs/cu. ft.
3. Thermal Conductivity: Not exceeding 0.25 BTU-in/hour sq. ft. ^{o}F at 75^{o}F mean temperature.

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

    a. CertainTeed Corp.
    b. Johns Manville.
    c. Knauf Insulation.
    d. Owens Corning Fiberglas Corp.

2. Density: 3.0 lbs/cu. ft.
3. Thermal Conductivity: Not exceeding 0.30 BTU-in/hour sq. ft. ^{o}F at 100^{o}F mean temperature.

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

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

    a. CertainTeed Corp.
    b. Johns Manville.
    c. Knauf Insulation.
    d. Manson Insulation Inc.

e. Owens Corning Fiberglas Corp.

2. Density: 3.0 lbs/cu. ft.
3. Thermal Conductivity: Not exceeding 0.23 BTU-in/hour sq. ft. ^{o}F at 75^{o}F mean temperature.

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

a. Johns Manville.
b. Owens Corning Fiberglas Corp.
c. Rock Wool Manufacturing Company.

2. Density: 3.0 lbs/cu. ft.
3. Thermal Conductivity: Not exceeding 0.30 BTU-in/hour sq. ft. ^{o}F at 100^{o}F mean temperature.

L. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Johns Manville.
b. Knauf Insulation.
c. Manson Insulation Inc.
d. Owens Corning Fiberglas Corp.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.
3. Thermal Conductivity: Not exceeding 0.23 BTU-in/hour sq. ft. ^{o}F at 75^{o}F mean temperature.

M. 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. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

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

a. CertainTeed Corp.
b. Johns Manville.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning Fiberglas Corp.

2. Density: 2.5 lbs/cu. ft.
3. Thermal Conductivity: Not exceeding 0.27 BTU-in/hour sq. ft. ^{o}F at 75^{o}F mean temperature.

2.2 INSULATING CEMENTS

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

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

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

a. Childers Products, Division of ITW.
b. Foster Products Corporation, H. B. Fuller Company.
c. Marathon Industries, Inc.
d. Mon-Eco Industries, Inc.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

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

a. Aeroflex USA Inc.
b. Armacell LCC.
c. Foster Products Corporation, H. B. Fuller Company.
d. RBX Corporation.

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

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

1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

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

a. Childers Products, Division of ITW.
b. Foster Products Corporation, H. B. Fuller Company.
c. ITW TACC, Division of Illinois Tool Works.
d. Marathon Industries, Inc.

e. Mon-Eco Industries, Inc.

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

F. PVC Jacket Adhesive: Compatible with PVC jacket.

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

a. Dow Chemical Company (The).
b. Johns-Manville.
c. P.I.C. Plastics, Inc.
d. Speedline Corporation

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

2.4 MASTICS

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

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

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

1. Childers Products, Division of ITW.
2. Foster Products Corporation, H. B. Fuller Company.
3. ITW TACC, Division of Illinois Tool Works.
4. Marathon Industries, Inc.
5. Mon-Eco Industries, Inc.

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

1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.05 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.

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

1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. Color: White.

2.5 SEALANTS

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

1. Childers Products, Division of ITW.
2. Foster Products Corporation, H. B. Fuller Company.
3. Marathon Industries, Inc.
4. Mon-Eco Industries, Inc.
5. Pittsburgh Corning Corporation.

B. Joint Sealants for Cellular Glass:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 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. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

2.8 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.

2.9 FIELD-APPLIED JACKETS

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

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

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

    a. Johns Manville.
    b. P.I.C. Plastics, Inc.
    c. Proto PVC Corporation.
    d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
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.

5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

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

    a. Childers Products, Division of ITW.
    b. PABCO Metals Corporation.
    c. RPR Products, Inc.

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

    a. Factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
    e. 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. Factory cut and rolled to size.
    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.
    e. 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.

E. 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.

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

2.10 TAPES

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

1. Avery Dennison Corporation, Specialty Tapes Division.
2. Compac Corp.
3. Ideal Tape Co., Inc., an American Biltrite Company.
4. Venture Tape.

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

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

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

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

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

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

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
3. 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.
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.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation 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.
3. 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.

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, ducts and fittings, and piping including fittings, valves, and specialties.

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

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

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

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

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

L. Install insulation with factory-applied jackets 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 as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and 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. Manholes.
5. Handholes.
6. 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. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

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 galvanized steel or aluminum, at least 0.040 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.

3.6 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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

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.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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 MINERAL-FIBER INSULATION INSTALLATION

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 but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe 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.

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

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

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

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

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

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

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

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

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

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

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

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

3.9 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.

3.10 FIRE-RATED INSULATION SYSTEM INSTALLATION

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

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

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

3.11 FINISHES

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

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. 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.
3. 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 for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.13 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return and relief air located in nonconditioned space.
4. Indoor, exposed return and relief air located in nonconditioned space, chiller room, boiler room, mechanical room.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Outdoor, concealed supply, return and relief air.
10. Outdoor, exposed supply, return and relief air.

B. Items Not Insulated:

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

3.14 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, rectangular, round and flat-oval, supply-air, outdoor-air, return air and relief-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick.
2. Mineral-Fiber Board: 1-1/2 inches thick.

B. Concealed, supply-air plenum, outdoor-air plenum, plenums for laminar flow diffusers and plenums for HEP filter equipped diffusers, insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-½ inches thick.
2. Mineral-Fiber Board: 1-½ inches thick.

C. Exposed rectangular, round and flat-oval, supply-air, outdoor-air, return-air and relief-air duct insulation shall be the following:

1. Mineral-Fiber Board: 1-½ inches thick.

D. Exposed, supply-air, outdoor-air and relief-air plenum insulation shall be the following:

1. Mineral-Fiber Board: 1-1/2 inches thick.

3.15 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, rectangular, round and flat-oval, supply-air, return-air and relief-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick.
2. Mineral-Fiber Board: 2 inches thick.

C. Concealed, supply-air and return-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick.
2. Mineral-Fiber Board: 2 inches thick.

D. Exposed, rectangular, round and flat-oval, supply-air, return-air and relief air duct and plenum insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick.

3.16 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Heat-exchanger (water-to-water for heating service and steam to hot water) insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.
2. Cellular Glass: 3 inches thick.
3. Mineral-Fiber Board: 2 inches thick.
4. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.17 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.

3.18 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

B. Chilled Water, Glycol and Brine:

1. NPS 4 and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

2. NPS 5 to NPS 8: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.

3. NPS 10 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

C. Heating-Hot-Water Supply and Return, Snow Melting Supply and Return:

1. NPS 2 and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

2. NPS 2-1/2 to NPS 6: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.

3. NPS 8 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

D. Steam, Steam Condensate, Boiler Feed Water, Condensate Pump Discharge, Condensate Pump Receiver Vent to 7 ft., Flash Tank Vent to 7 ft., Steam Relief Vent:

1. NPS 2 and Smaller: Insulation shall be one of the following:

a. Calcium Silicate: 2 inches thick.
b. Cellular Glass: 1-1/2 inches thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

2. NPS 2-1/2 to NPS 6: Insulation shall be one of the following:

a. Calcium Silicate: 3 inches thick.
b. Cellular Glass: 2 inches thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches thick.

3. NPS 8 and Larger: Insulation shall be one of the following:

a. Calcium Silicate: 4 inches thick.
b. Cellular Glass: 3 inches thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches thick.

E. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

F. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

G. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Calcium Silicate: 1-1/2 inches thick.
b. Cellular Glass: 1-1/2 inches thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

H. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Calcium Silicate: 1-1/2 inches thick.
b. Cellular Glass: 1-1/2 inches thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

    a. Flexible Elastomeric: 2 inches thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

    a. Flexible Elastomeric: 2 inches thick.

3.20 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. Ducts and Plenums, Concealed:

1. None.

D. Ducts and Plenums, Exposed:

1. None.

E. Equipment, Concealed:

1. None.

F. Equipment, Exposed:

1. None.

G. Piping, Concealed:

1. None.

H. Piping, Exposed:

1. None.

END OF SECTION

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F.
    b. Water Flow: Plus or minus 5 percent of full scale.
    c. Water Pressure: Plus or minus 2 percent of full scale.
    d. Space Temperature: Plus or minus 1 deg F.
    e. Ducted Air Temperature: Plus or minus 1 deg F.
    f. Outside Air Temperature: Plus or minus 2 deg F.
    g. Dew Point Temperature: Plus or minus 3 deg F.
    h. Temperature Differential: Plus or minus 0.25 deg F.
    i. Relative Humidity: Plus or minus 5 percent.
    j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
    k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
    l. Airflow (Terminal): Plus or minus 10 percent of full scale.
    m. Air Pressure (Space): Plus or minus 0.01-inch wg.
    n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
    o. Carbon Monoxide: Plus or minus 5 percent of reading.
    p. Carbon Dioxide: Plus or minus 50 ppm.
    q. Electrical: Plus or minus 5 percent of reading.

1.5 SEQUENCE OF OPERATION

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.

E. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

F. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

G. Qualification Data: For Installer and manufacturer.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.

C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.

E. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.

F. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

G. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

I. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

J. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

K. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

L. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.10 EXTRA MATERIALS

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

1. Maintenance Materials: One thermostat adjusting key(s).
2. Maintenance Materials: One pneumatic thermostat test kit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 CONTROL SYSTEM

A. Acceptable Manufacturers:

1. Johnson Controls, Inc.; Controls Group.

2.3 CONTROL SYSTEM COMPONENTS

A. Acceptable Manufacturers:

1. Alerton Inc.
2. American Auto-Matrix.
3. BEC Controls Corporation.
4. Belimo Aircontrols.
5. Cleveland Control.

6. Delta Controls Inc.
7. Ebtron, Inc.
8. Functional Devices Inc.
9. Grasslin Controls Corp.
10. Hayward Industrial Products, Inc.
11. Hoffman Enclosures, Inc.
12. Kele Inc.
13. Leslie Controls, Inc.
14. MAMAC Systems, Inc.
15. Magnatrol Valve Corp.
16. Parker Hannifin Corp.
17. Paragon Electric Co.
18. Setra Corporation.
19. Solidyne Corp.
20. Spence Engineering Company, Inc.
21. TCS/Basys Controls.
22. tekmar Control Systems, Inc.
23. Teletrol Systems Incorporated.
24. Time Mark Corporation.
25. Tour & Andersson Control, Inc.
26. Triangle MicroSystems, Inc.
27. Vaisala, Inc.
28. Veris Industries.
29. Voltec, Inc.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

C. Control system shall include the following:

1. Building lighting control system specified in Division 26 Section "Network Lighting Controls."

2.4 DDC EQUIPMENT

A. Operator Workstation: PC-based microcomputer(s) with minimum configuration as follows:

1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
2. Processor: Intel Pentium 4, 1.7 GHz.
3. Random-Access Memory: 512 MB.
4. Graphics: Video adapter, minimum 1280 x 1024 pixels, 64-MB video memory, with TV out.
5. Monitor: 21 inches**,** LCD color.
6. Keyboard: QWERTY, 105 keys in ergonomic shape.
7. Floppy-Disk Drive: 1.44 MB.
8. Hard-Disk Drive: 80 GB.
9. CD-ROM Read/Write Drive: 48x24x48.
10. Mouse: Three button, optical.

11. Uninterruptible Power Supply: Two (2) kVa.
12. Operating System: Microsoft Windows XP Professional with high-speed Internet access.

    a. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

13. Printer: Color, ink-jet type as follows:

    a. Print Head: 4800 x 1200 dpi optimized color resolution.
    b. Paper Handling: Minimum of 100 sheets.
    c. Print Speed: Minimum of 17 ppm in black and 12 ppm in color.

14. Application Software:

    a. I/O capability from operator station.
    b. System security for each operator via software password and access levels.
    c. Automatic system diagnostics; monitor system and report failures.
    d. Database creation and support.
    e. Automatic and manual database save and restore.
    f. Dynamic color graphic displays with up to 10 screen displays at once.
    g. Custom graphics generation and graphics library of HVAC equipment and symbols.
    h. Alarm processing, messages, and reactions.
    i. Trend logs retrievable in spreadsheets and database programs.
    j. Alarm and event processing.
    k. Object and property status and control.
    l. Automatic restart of field equipment on restoration of power.
    m. Data collection, reports, and logs. Include standard reports for the following:

        1) Current values of all objects.
        2) Current alarm summary.
        3) Disabled objects.
        4) Alarm lockout objects.
        5) Logs.

    n. Custom report development.
    o. Utility and weather reports.
    p. Workstation application editors for controllers and schedules.
    q. Maintenance management.

15. Custom Application Software:

    a. English language oriented.
    b. Full-screen character editor/programming environment.
    c. Allow development of independently executing program modules with debugging/simulation capability.
    d. Support conditional statements.
    e. Support floating-point arithmetic with mathematic functions.
    f. Contains predefined time variables.

B. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
2. Processor: Intel Pentium 4, 800 MHz.
3. Random-Access Memory: 128 MB.
4. Graphics: Video adapter, minimum 1024 x 768 pixels, 64-MB video memory.
5. Monitor: 17 inches, LCD color.
6. Keyboard: QWERTY 105 keys in ergonomic shape.
7. Floppy-Disk Drive: 1.44 MB.
8. Hard-Disk Drive: 10 GB.
9. CD-ROM Read/Write Drive: 48x24x48.
10. Pointing Device: Touch pad or other internal device.

C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Software applications, scheduling, and alarm processing.
    e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

    a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
    b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
    d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    e. Remote communications.
    f. Maintenance management.
    g. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.5 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.6 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch-thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.

1. Alarm Condition: Indicating light flashes and horn sounds.
2. Acknowledge Switch: Horn is silent and indicating light is steady.
3. Second Alarm: Horn sounds and indicating light is steady.
4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.7 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan

speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.

1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
2. Proportional band shall extend from 2 to 20 percent for 5 psig.
3. Authority shall be 20 to 200 percent.
4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
5. Gages: 1-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.8 TIME CLOCKS

A. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.9 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.5 deg F at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: Minimum 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Concealed, Red-reading glass.
    d. Orientation: Horizontal.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: Minimum 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Concealed, Red-reading glass.
    d. Orientation: Horizontal.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 5 percent full range with linear output.
2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Concealed.
    b. Set-Point Indication: Concealed.
    c. Orientation: Horizontal.

4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 10 to plus 100 deg F.
6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

    a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    b. Output: 4 to 20 mA.
    c. Building Static-Pressure Range: 0- to 0.25-inch wg.
    d. Duct Static-Pressure Range: 0- to 5-inch wg.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.10 PNEUMATIC SENSORS

A. Pneumatic Transmitters: Vibration and corrosion resistant.

1. Space-Temperature Sensors: Linear-output type, 50 to 100 deg F range, with blank locking covers matching room thermostats.
2. Room Return-Air Temperature Sensors: Linear-output type with bimetal sensing element and corrosion-proof construction, 50 to 100 deg F range, designed to be mounted in light troffers.
3. Duct-Mounted or Immersion-Type Temperature Sensors: Range as required for 3- to 15-psig output signal.
4. Temperature Transmitters: Rigid-stem type with bimetal sensing elements unless averaging is required, 3- to 15-psig output signal.

    a. Averaging-Element Sensors: Single- or multiple-unit capillary elements.
    b. Tamperproof Sensors: Corrosion-resistant construction, suitable for mounting on vibrating surface with exposed capillary protected with temperature-compensated armor or protective tubing.
    c. Pipe-Mounted Temperature-Sensing Elements: Rod-and-tube type; with separable wells filled with heat-conductive compound.
    d. Outdoors: Provide bulb shield with mounting bracket.

5. Space and Duct Humidity Transmitters: One pipe, directly proportional, with minimum sensing span of 20 to 80 percent relative humidity for 3- to 15-psig output signal, corrosion resistant and temperature compensated, and with factory-calibrated adjustment.

    a. Space Mounting: With covers to match thermostats.

6. Differential-Pressure Transmitters: One pipe, direct acting for gas, liquid, or steam service; pressure sensor and transmitter of linear-output type; with range of 0 to 50 psig, and 3- to 15-psig output signal.
7. Differential-Air-Pressure Transmitters: One pipe, direct acting, double bell; unidirectional with suitable range for expected input; and temperature compensated.

    a. Accuracy: 5 percent of full range and 2 percent of full scale at midrange.
    b. Output Signal: 3 to 15 psig.

B. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to 0 to 20 psig.

C. Pneumatic Valve/Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

2.11 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.12 GAS DETECTION EQUIPMENT

A. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F; with 2 factory-calibrated alarm levels at 50 and 100 ppm.

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output, for wall mounting.

C. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

D. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.13 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

1. Label switches "FAN ON-OFF", "FAN HIGH-LOW-OFF", "FAN HIGH-MED-LOW-OFF".

2. Mount on single electric switch box.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

a. Time of day.
b. Actual room temperature.
c. Programmed temperature.
d. Programmed time.
e. Duration of timed override.
f. Day of week.
g. System mode indications include "heating," "off," "fan auto," and "fan on."

C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

E. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

F. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:

1. Reset: Manual.
2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.

G. Pneumatic Room Thermostats: Two pipe(s), fully proportional with adjustable throttling range and tamperproof locking settings, direct or reverse acting as required. Factory calibrated at 2.5 psig/deg F.

1. Factory Calibration: 2.5 psig/deg F.
2. Range: 45 to 85 deg F.
3. Sensitivity Adjustment Range: 1 to 4 psig/deg F.
4. Dual-Temperature Thermostats: Automatic changeover from normal setting to lower setting for unoccupied cycles, with manual-reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.
5. Limits: Field adjustable, to limit setting cooling set point below 75 deg F, and heating set point above 75 deg F.
6. Room Thermostat Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Concealed, Red-reading glass.
    d. Orientation: Horizontal.

7. Room thermostat accessories include the following:

    a. Insulating Bases: For thermostats located on exterior walls.
    b. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
    c. Adjusting Key: As required for calibration and cover screws.
    d. Aspirating Boxes: For flush-mounted aspirating thermostats.
    e. Set-Point Adjustment: 1/2-inch-diameter, adjustment knob.

H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

I. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

J. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

K. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

L. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.14 HUMIDISTATS

A. Pneumatic Room Humidistats: Wall-mounting, proportioning type with adjustable throttling range, 25 to 65 percent operating range, and cover matching room thermostat cover.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

C. Pneumatic Duct-Mounting Humidistats: Proportioning type with adjustable throttling range, 20 to 90 percent operating range, in galvanized-steel duct box.

2.15 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

3. Coupling: V-bolt and V-shaped, toothed cradle.

4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return): 24-V ac.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: Minus 22 to plus 122 deg F.
10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
11. Run Time: 12 seconds open, 5 seconds closed.

C. Pneumatic Valve Operators: Rolling-diaphragm, spring-loaded, piston type with spring range as required and start-point adjustment and positioning relay. Operator shall maintain full shutoff at maximum pump differential pressure.

D. Pneumatic Damper Operators: Rolling-diaphragm, piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Where actuators operate in sequence, provide pilot positioners.

1. Pilot Positioners: With the following characteristics:

   a. Start Point: Adjustable from 2 to 12 psig.
   b. Operating Span: Adjustable from 5 to 13 psig.
   c. Linearity: Plus or minus 10 percent of output signal span.
   d. Hysteresis: 3 percent of span.
   e. Response: 0.25-psig input change.
   f. Maximum Pilot Signal Pressure: 20 psig.
   g. Maximum Control Air-Supply Pressure: 60 psig.

2. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140 deg F unless located in return-air plenums.

2.16 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic system valves shall have the following characteristics:

1. Control valves shall be pressure independent. The flow through the valve shall not vary more than +/- 5% (due to system pressure fluctuations) across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.
2. The valve bodies shall be of cast iron, steel or bronze rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass or bronze.
3. Valves shall be DeltaP Valves manufactured by Flow Control Industries, Belimo or approved equal.

   a. Valves providing two-position service, except boiler isolation valve and boiler water minimum flow bypass valve, shall be quick opening. Two-way valves shall have replaceable disc or ball.

b. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.

1) Two-way: 150% of total system (pump) head.
2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

c. Ports. Valves providing modulating service shall have equal percentage ports.
d. Sizing.

1) Two-position service: line size.
2) Two-way modulating service: select pressure drop equal to (3 psi).
3) Three-way modulating service: (3 psi).

e. Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.

1) Water zone valves: normally open.
2) Heating coils in air handlers: normally open.
3) Chilled water control valves: normally closed.

C. Steam system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel seats.

a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

4. Sizing: For pressure drop based on the following services:

a. Two Position: 20 percent of inlet pressure.
b. Modulating 15-psig Steam: 5 psig.
c. Modulating 16- to 50-psig Steam: 10 psig.
d. Modulating More Than 50-psig Steam: 10 psig.

5. Flow Characteristics: Modified linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.

D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Lug.
2. Disc Type: Nickel-plated ductile iron.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

F. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Thermostatic Operator: Liquid-filled integral sensor with integral adjustable dial.

2.17 DAMPERS

A. Dampers: AMCA-rated, parallel or opposed-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.18 AIR SUPPLY

A. Control and Instrumentation Tubing: Copper tubing complying with ASTM B 88, Type L or ASTM B 280 Type ACR.

1. Fittings: Cast-bronze solder fittings complying with ASME B16.18; or wrought-copper solder fittings complying with ASME B16.22, except forged-brass compression-type fittings at connections to equipment.
2. Joining Method: Soldered or brazed.

B. Control and Instrumentation Tubing: ASTM D 2737 Type FR plenum-rated polyethylene, flame-retardant, nonmetallic tubing rated for 30 psig and ambient temperature range of 10 to 150 deg F with flame-retardant harness for multiple tubing.

1. Fittings: Compression or push-on polyethylene fittings.

C. Tank: ASME storage tank with drain test cock, automatic moisture removal trap, tank relief valve, and rubber-cork vibration isolation mounting pads.

D. Duplex Air Compressor: Capacity to supply compressed air to temperature-control system.

1. Pressure control with adjustable electric contacts, set to start and stop both compressors at different pressures.
2. Electrical alternation set with motor starters and disconnect to operate compressors alternately or on time schedule.

E. Simplex Air Compressor: Tank-mounting compressor with capacity to supply compressed air to temperature-control system, with starter and disconnect.

1. Pressure control with adjustable electric contacts, set to start and stop compressor.

F. Compressor Type: Reciprocating or Scroll.

G. Size compressor and tank to operate compressor not more than 20 minutes during a 60-minute period.

H. Compressor Accessories: Low-resistance intake-air filter, and belt guards.

I. System Accessories: Air filter rated for 97 percent efficiency at rated airflow, and combination filter/pressure-reducing station or separate filter and pressure-reducing station.

J. Refrigerated Air Dryer: Two Self-contained, refrigerated air dryers complete with heat exchangers, moisture separator, internal wiring and piping, and with manual bypass valve. Each dryer sized to handle rated airflow capacity of one compressor.

1. Heat Exchangers: Air-to-refrigerant coils with centrifugal-type moisture separator and automatic trap assembly.
2. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 13 deg F at 20 psig, housed in steel cabinet with access door and panel.
3. Accessories: Air-inlet temperature gage, air-inlet pressure gage, on-off switch, high-temperature light, power-on light, refrigerant gage on back, air-outlet temperature gage, air-outlet pressure gage, and with contacts for remote indication of power status and high-temperature alarm.

K. Desiccant Dryer: Obtains dew point in pneumatic air piping between compressor and tank at least 15 deg F below inlet-air dew point at design conditions.

L. Pressure Gages: Black letters on white background, 2-1/2 inches in diameter, flush or surface mounting, with front calibration screw to match sensor, and having a graduated scale in psig.

M. Instrument Pressure Gages: Black letters on white background, 1-1/2 inches in diameter, stem mounted, with suitable dial range.

N. Diaphragm Control and Instrument Valves: 1/4-inch forged-brass body with reinforced polytetrafluoroethylene diaphragm, stainless-steel spring, and color-coded phenolic handle.

O. Gage Cocks: Tee or level handle, bronze, rated for 125 psig.

P. Relays: For summing, reversing, and amplifying highest or lowest pressure selection; with adjustable I/O ratio.

Q. Switches: With indicating plates and accessible adjustment; calibrated and marked.

R. Pressure Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve.

S. Particle Filters: Zinc or aluminum castings with 97 percent filtration efficiency at rated airflow, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.

T. Combination Filter/Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve; with threaded pipe connections, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.

U. Airborne Oil Filter: Filtration efficiency of 99.9 percent for airborne lubricating oil particles of 0.025 micron or larger.

V. Pressure Relief Valves: ASME rated and labeled.

1. High Pressure: Size for installed capacity.
2. Low Pressure: Size for installed capacity of pressure regulators and set at 20 percent above low pressure.

W. Pressure-Reducing Stations: Two parallel pressure regulators.

2.19 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Mount compressor and tank unit on vibration devices. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's written instructions and seismic-control requirements.

1. Pipe manual and automatic drains to nearest floor drain.
2. Supply instrument air from compressor units through filter, pressure-reducing valve, and pressure relief valve, with pressure gages and shutoff and bypass valves.

D. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

F. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

I. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

J. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

K. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

L. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

M. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 PNEUMATIC PIPING INSTALLATION

A. Install piping in mechanical equipment rooms inside mechanical equipment enclosures, in pipe chases, or suspended ceilings with easy access.

1. Install copper tubing with maximum unsupported length of 36 inches, for tubing exposed to view.
2. Install polyethylene tubing in metallic raceways or electrical metallic tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install terminal single-line connections, less than 18 inches in length, with copper or polyethylene tubing run inside flexible steel protection.

C. In concealed locations such as pipe chases and suspended ceilings with easy access, install copper or polyethylene tubing in electrical metallic tubing. Electrical metallic tubing materials

and installation requirements are specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

D. In concrete slabs, furred walls, or ceilings with no access, install copper or polyethylene tubing in electrical metallic tubing or vinyl-jacketed polyethylene tubing.

1. Protect embedded-copper and vinyl-jacketed polyethylene tubing with electrical metallic tubing extending 6 inches above finished slab and 6 inches into slab. Pressure test tubing before and after pour for leak and pinch.
2. Install polyethylene tubing in electrical metallic tubing extending 6 inches above floor line; pull tubing into electrical metallic tubing after pour.

E. Install tubing with sufficient slack and flexible connections to allow for vibration of piping and equipment.

F. Purge tubing with dry, oil-free compressed air before connecting control instruments.

1. Bridge cabinets and doors with flexible connections fastened along hinge side; protect against abrasion. Tie and support tubing.

G. Number-code or color-code control air piping for future identification and service of control system, except local individual room control tubing.

H. Pressure Gages or Test Plugs: Install on branch lines at each receiver controller and on signal lines at each transmitter, except individual room controllers.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

F. All power wiring (120 volt and higher) for equipment motor, for smoke dampers, for combination fire/smoke dampers, wiring shown on electrical drawings, and fire alarm wiring shall be furnished and installed under Division 26. All remaining control wiring required to achieve service of control as specified and communication wiring for smoke and combination fire/smoke damper shall be furnished and installed under Division 23.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.
5. Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.
6. Test calibration of pneumatic and electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
7. Test each point through its full operating range to verify that safety and operating control set points are as required.
8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
9. Test each system for compliance with sequence of operation.
10. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:

a. Verify that DDC controller power supply is from emergency power supply, if applicable.
b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
c. Verify that spare I/O capacity has been provided.
d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

a. Check analog inputs at 0, 50, and 100 percent of span.
b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
c. Check digital inputs using jumper wire.
d. Check digital outputs using ohmmeter to test for contact making or breaking.
e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of final acceptance by Owner, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to four visits to Project during other than normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Glycol cooling-water piping.
4. Makeup-water piping.
5. Condensate-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature, unless noted otherwise:

1. Hot-Water Heating Piping: 100 psig at 200 deg F.
2. Chilled-Water Piping: 100 psig at 200 deg F.
3. Glycol Cooling-Water Piping: 100 psig at 150 deg F.
4. Makeup-Water Piping: 80 psig at 150 deg F.
5. Condensate-Drain Piping: 150 deg F.
6. Air-Vent Piping: 200 deg F.

7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

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

1. RTRP and RTRF with adhesive.
2. Pressure-seal fittings.
3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
4. Air control devices.
5. Chemical treatment.
6. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Qualification Data: For Installer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

G. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Wrought-Copper Fittings: ASME B16.22.

D. Grooved-Joint Fittings and Couplings:

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

    a. Anvil International, Inc.
    b. S. P. Fittings; a division of Star Pipe Products.
    c. Victaulic Company of America.

2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

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

    a. T-DRILL Industries Inc.

F. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel with plain ends; Type S or E or Grade B, Schedule 40.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

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

a. Anvil International, Inc.
b. National Fittings, Inc.
c. S. P. Fittings; a division of Star Pipe Products.
d. Victaulic Company of America.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

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

F. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Use fiberglass adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

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

a. Capitol Manufacturing Company.
b. Hart Industries International, Inc.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
d. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

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

a. Capitol Manufacturing Company.
b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

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

a. Advance Products & Systems, Inc.

b. Calpico, Inc.
c. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

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

a. Calpico, Inc.
b. Lochinvar Corporation.

2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples:

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

a. Perfection Corporation; a subsidiary of American Meter Company.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Victaulic Company of America.

2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Balancing Valves:

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

a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Flow Design Inc.
d. Griswold Controls.
e. Taco.

2. Bronze, Calibrated – Orifice Type:

a. Body: Bronze, ball or plug type with calibrated orifice or venturi.
b. Ball: Brass or stainless steel.
c. Plug: Resin.
d. Seat: PTFE.
e. End Connections: Threaded or socket.
f. Pressure Gage Connections: Integral seals for portable differential pressure meter.
g. Handle Style: Lever, with memory stop to retain set position.
h. CWP Rating: Minimum 125 psig.
i. Maximum Operating Temperature: 250 deg F.

3. Cast-Iron or Steel, Calibrated-Orifice Type:

a. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
b. Ball: Brass or stainless steel.
c. Stem Seals: EPDM O-rings.
d. Disc: Glass and carbon-filled PTFE.
e. Seat: PTFE.
f. End Connections: Flanged or grooved.
g. Pressure Gage Connections: Integral seals for portable differential pressure meter.
h. Handle Style: Lever, with memory stop to retain set position.
i. CWP Rating: Minimum 125 psig.
j. Maximum Operating Temperature: 250 deg F.

D. Diaphragm-Operated, Pressure-Reducing Valves:

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

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Conbraco Industries, Inc.
e. Spence Engineering Company, Inc.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Diaphragm-Operated Safety Valves:

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

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Conbraco Industries, Inc.
e. Spence Engineering Company, Inc.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Automatic Flow-Control Valves:

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

a. Flow Design Inc.
b. Griswold Controls.

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bonze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

2.6 AIR CONTROL DEVICES

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

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch-diameter gage glass, and slotted-metal glass guard.

E. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.7 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

B. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

D. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

E. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping/chilled-water piping/dual-temperature heating and cooling water piping, aboveground, NPS 2 and smaller:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

B. Hot-water heating piping/chilled-water piping/dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2**,** shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Hot-water heating piping/chilled-water piping/dual-temperature heating and cooling water piping installed belowground and within slabs shall be either of the following:

1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered or brazed joints. Use the fewest possible joints.
2. RTRP and RTRF with adhesive or flanged joints.

D. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

E. Makeup-Water Piping Installed Belowground and within Slabs: Type L, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

F. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type L, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to

the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.

15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

J. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

K. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

L. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

G. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

H. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.8 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the water characteristics as required by the Owner.

B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

D. Fill systems indicated to have antifreeze or glycol solutions with the concentrations indicated on drawings or as required by the system.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 22 13

STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for LP and HP steam and condensate piping:

1. Pipe and fittings.
2. Strainers.
3. Safety valves.
4. Steam traps.
5. Thermostatic air vents and vacuum breakers.

1.3 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless noted otherwise:

1. HP Steam Piping: 150 psig.
2. LP Steam Piping: 150 psig.
3. Condensate Piping: 150 psig at 250 deg F.
4. Makeup-Water Piping: 80 psig at 150 deg F.
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 SUBMITTALS

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

1. Pressure-reducing and safety valve.

2. Steam trap.
3. Air vent and vacuum breaker.

B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

C. Qualification Data: For Installer.

D. Welding certificates.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify processes and operators according to the following:

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings and Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel, plain ends, Type S (seamless) or E (electric-resistance welded), Grade B, and Schedule 40 or 80 as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

I. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150-psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

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

F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

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

   a. Capitol Manufacturing Company.
   b. Hart Industries, International Inc.
   c. Watts Water Technologies, Inc.
   d. Zurn Plumbing Products Group.

2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

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

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

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

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure as required to suit system pressures.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Stop-Check Valves:

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

    a. Crane Co.
    b. Jenkins Valves; a Crane Company.
    c. Lunkenheimer Valves.
    d. A.Y. McDonald Mfg. Co.

2. Body and Bonnet: Malleable iron.
3. End Connections: Flanged.
4. Disc: Cylindrical with removable liner and machined seat.
5. Stem: Brass alloy.
6. Operator: Outside screw and yoke with cast-iron handwheel.
7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
8. Pressure Class: 250.

2.6 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

B. Basket Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 250-psig working steam pressure.

2.7 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.8 SAFETY VALVES

A. Bronze or Brass Safety Valves:

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

    a. Armstrong International, Inc.
    b. Kunkle Valve; a Tyco International Ltd. Company.
    c. Spirax Sarco, Inc.
    d. Watts Water Technologies, Inc.

2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:

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

    a. Armstrong International, Inc.
    b. Kunkle Valve; a Tyco International Ltd. Company.
    c. Spirax Sarco, Inc.
    d. Watts Water Technologies, Inc.

2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.9 STEAM TRAPS

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

1. Armstrong International, Inc.
2. Dunham-Bush, Inc.
3. Hoffman Specialty; Division of ITT Industries.
4. Spirax Sarco, Inc.

B. Thermostatic Traps:

1. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
2. Trap Type: Balanced-pressure.
3. Bellows: Stainless steel or monel.
4. Head and Seat: Replaceable, hardened stainless steel.
5. Pressure Class: 125.

C. Thermodynamic Traps:

1. Body: Stainless steel with screw-in cap.
2. End Connections: Threaded.
3. Disc and Seat: Stainless steel.
4. Maximum Operating Pressure: 600 psig.

D. Float and Thermostatic Traps:

1. Body and Bolted Cap: ASTM A 126, cast iron.
2. End Connections: Threaded.
3. Float Mechanism: Replaceable, stainless steel.
4. Head and Seat: Hardened stainless steel.
5. Trap Type: Balanced pressure.
6. Thermostatic Bellows: Stainless steel or monel.
7. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
8. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
9. Maximum Operating Pressure: 125 psig.

E. Inverted Bucket Traps:

1. Body and Cap: Cast iron.
2. End Connections: Threaded.
3. Head and Seat: Stainless steel.
4. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
5. Bucket: Brass or stainless steel.
6. Strainer: Integral stainless-steel inlet strainer within the trap body.
7. Air Vent: Stainless-steel thermostatic vent.
8. Pressure Rating: 250 psig.

2.10 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

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

   a. Armstrong International, Inc.
   b. Dunham-Bush, Inc.
   c. Hoffman Specialty; Division of ITT Industries.
   d. Spirax Sarco, Inc.

2. Body: Cast iron, bronze or stainless steel.

3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:

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

   a. Armstrong International, Inc.
   b. Dunham-Bush, Inc.
   c. Hoffman Specialty; Division of ITT Industries.
   d. Johnson Corporation (The).
   e. Spirax Sarco, Inc.

2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring and Screen: Stainless steel.
5. O-ring Seal: EPR.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 and Larger: Schedule 40, Type E, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 300 malleable-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, steel pipe; Class 250 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping below grade, NPS 2 and smaller, shall be either of the following:

1. Schedule 80, Type S, steel pipe; Class 125 cast-iron fittings; and threaded joints.

F. Condensate piping below grade, NPS 2-1/2 and larger, shall be either of the following:

1. Schedule 80, Type E, steel pipe; Class 250 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, NPS 2: Schedule 40, Type S, steel pipe; Class 300 malleable-iron fittings; and threaded joints.

B. HP Steam Piping, NPS 2-1/2 and Larger: Schedule 40, Type E, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, steel pipe; Class 300 malleable-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.3 ANCILLARY PIPING APPLICATIONS

A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Air-Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

C. Vacuum-Breaker Piping: Outlet, same as service where installed.

D. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.5 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. 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 free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 150 ft.
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

3.6 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.7 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.8 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 9 feet; minimum rod size, ¼ inch.
2. NPS 1: Maximum span, 9 feet; minimum rod size, ¼ inch.
3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.

6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 17 feet; minimum rod size, ½ inch.
8. NPS 6: Maximum span, 21 feet; minimum rod size, ½ inch.
9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 26 feet; minimum rod size, ¾ inch.
11. NPS 12: Maximum span, 30 feet; minimum rod size, 7/8 inch.
12. NPS 14: Maximum span, 32 feet; minimum rod size, 1 inch.
13. NPS 16: Maximum span, 35 feet; minimum rod size, 1 inch.
14. NPS 18: Maximum span, 37 feet; minimum rod size, 1-1/4 inches.
15. NPS 20: Maximum span, 39 feet; minimum rod size, 1-1/4 inches.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 4 feet; minimum rod size, 1/4 inch.
2. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.9 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.10 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.11 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION

SECTION 23 27 00

UVC FIXTURES FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fixtures with germicidal ultraviolet lamps for application on ducted HVAC systems, and within air handling units.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating weights, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of UVC fixtures. Include plans, elevations, sections, details of mountings.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
2. Coordination Drawings: Detail UVC fixtures and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.

C. Maintenance Data: For UVC fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. UL Compliance:

1. Comply with UL Standard 900 as applicable to listing of air filters.
2. Comply with UL 984 – Safety Standards for Hermetic Motor Compressors.
3. Comply with UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.

C. Certification: The manufacturer shall certify that UV radiation through the air handling unit access door and window shall meet OSHA requirements. Provide certification to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store UVC fixtures in a clean, dry place and protect from weather and construction traffic. Handle UVC fixtures carefully to avoid damage to components, enclosures, and finish. Leave factory-shipping covers in place until installation is complete. Do not install any damaged components; instead replace them and return damaged components to equipment manufacturer.

B. Comply with manufacturers' installation instructions regarding wiring and testing and to the drawings and/or specification regarding exact fixture placement for proper energy distribution.

1.6 EXTRA MATERIALS

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

1. Supply one replacement UV lamp of each different length.

1.7 COORDINATION

A. Coordinate location and installation of UVC fixtures in ducts and air-handling units. Revise locations and elevations to suit field conditions and to ensure proper operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. UVC Fixtures:

a. Sterile-Aire, Inc.
b. Ultra Violet Devices, Inc.

2.2 UVC FIXTURES

A. Quality Assurance:

1. Qualifications: UVC products shall be from an ISO 9001 manufacturer or the supplier shall provide proof of 100% inbound and outbound testing of equipment.
2. Lamps: Each lamp shall contain no more than 8 milligrams of mercury consistent with current environmental practices while producing the specified output at 500 fpm in temperatures of 55-135^{o}F. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They shall be constructed with UVA proof metal bases and shall not produce ozone.
3. Warranty:

a. Fixtures shall be warranted to be free from defects for a period of one year, from data of final acceptance.

b. Lamps shall be warranted to be free from defects for a period of one year, from date of final acceptance.

B. Design Requirements:

1. Irradiation: Lamps and fixtures shall be installed in sufficient quantity and in such a manner so as to provide an equal distribution of UVC energy. When installed, the average intensity striking the intended surface shall not be less than 200 microwatts per square centimeter. Note: The applied energy and its distribution average shall be verified using third party math modeling and that verification shall be included with the submittal.
2. Intensity: The minimal UVC energy striking a surface shall be sufficient to continuously destroy a mono-layer of mold and bacteria as typically found in HVAC systems in less than six hours. The third party mathematical modeling shall include the destruction time for at least four of the most common HVAC microbes and an energy distribution map.
3. Installation: Fixture rows shall be electrically terminated to factory supplied hard wire boxes to meet UL and local electrical codes. Fixtures shall be mounted to irradiate the intended surface(s) as well as all of the available line of sight airstream by proper placement and incident angle reflection. Third party irradiation and intensity calculations (modeling) shall determine fixture placement and energy distribution and shall be provided in the submittal if such placement is absent on the plans.

C. Equipment:

1. Fixtures shall be track mounted to the appropriate factory supplied hardware to form horizontal rows that provide for the fixture support. Fixtures shall be equipped with UL approved fixture-to-fixture mechanical and electrical connections that facilitate proper installation and coupling to A/C power from one end. Fixtures shall be capable of being mounted anywhere in the system and/or as shown on the plans.
2. When used for surface irradiation, the fixture assembly shall be designed and installed such that the sum of the lamp arc lights in a row shall be equal to a minimum of 90% of the surfaces total width.
3. Fixtures shall meet the “UL” drip proof design and each fixture shall be equipped with an electrical interlock, which will not allow the fixture to energize unless it is properly installed to its factory supplied mounting track.
4. Fixtures shall be constructed of type 304 stainless steel to preclude corrosion.
5. Power supplies shall be of the high efficiency electronic type, matched to the lamp and designed to maximize UVC photon production, radiance and reliability. They shall be UL Listed and labeled for use in air-streams of 55-135^{o}F. They shall be capable of producing the specified output and organism destruction as specified under Irradiation and Intensity at no more than 13 watts of power consumption for each square foot of treated, cross sectional plane.
6. Each lamp shall contain no more than 8 milligrams of mercury consistent with current environmental practices while producing the specified output at 500 fpm in temperatures of 55-135^{o}F. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They shall be constructed with UVC proof metal bases and shall not produce ozone.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION OF UVC FIXTURES

A. Coordinate with installation of HVAC equipment and install fixtures as indicated above after such equipment is properly installed.

B. Provide an interlock switch on all access panels and doors leading to the UVC assembly and/or within view of the fixtures to assure that the UVC assembly will be de-energized when any of these accesses are opened.

C. Install Caution Labels on all accesses to the fixtures.

3.3 CONNECTIONS

A. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

B. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including supports and electrical connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain UVC fixture.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."

3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round and flat-oval ducts and fittings.
4. Double-wall round and flat-oval ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

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

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

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

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

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

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

C. Coordination Drawings: CAD generated plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

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

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

7. Refer to Section “Common Work Results for HVAC”.

D. Welding certificates.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

D. Duct liner shall be utilized where indicated on drawings.

E. Duct liner shall not be utilized in healthcare facilities, unless noted otherwise.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

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

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

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

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

F. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent or solid sheet steel where indicated.

G. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

H. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent or solid sheet steel, where indicated.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 SHEET METAL MATERIALS

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

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

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

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653.

1. Galvanized Coating Designation: G60.
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface].
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

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

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

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

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

2.6 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

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

    a. Aeroflex USA Inc.
    b. Armacell LLC.
    c. NOMACO Insulation.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 090A or NFPA 90B.

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

B. Insulation Pins and Washers:

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

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 SEALANT AND GASKETS

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

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.

5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

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

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

G. Round Duct Joint O-Ring Seals:

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

2.8 HANGERS AND SUPPORTS

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

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

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

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

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

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

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

H. Trapeze and Riser Supports:

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

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

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

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

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

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

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

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

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

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

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

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

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

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

B. Seal ducts before external insulation is applied. Provide adequate sealing as required to meet duct leakage requirements.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

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

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

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

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

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

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

3.4 CONNECTIONS

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

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

3.5 PAINTING

A. Paint interior of metal ducts, for 24 inches length, that are visible through return and exhaust registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Maximum Allowable Leakage: Duct system leakages shall not exceed 5% of design air flows. When systems are leak tested in section, the total cumulative leakage of the system shall not exceed 5%.
3. Test the following systems:

    a. All supply air ducts and sections from air handling unit to terminal units.
    b. All return air ducts and sections from grilles/registers to return/relief air fan.
    c. 10% of supply air ductwork downstream of boxes, but not less than two systems.
    d. Two exhaust air duct systems.

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

C. Duct System Cleanliness Tests:

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

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

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

E. Prepare test and inspection reports.

3.7 START UP

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

3.8 DUCT SCHEDULE

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

1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply Ducts:

1. Downstream of Air Handling Units and Up to Terminal Units:

a. Pressure Class: Positive 4-inch wg.

2. From Terminal Units to Outlets:

a. Pressure Class: Positive 2-inch wg.

3. Ducts Located within Mechanical Equipment Rooms:

a. Pressure Class: Positive 2-inch wg.

C. Return Ducts:

1. All Ducts:

a. Pressure Class: Negative 4-inch wg.

D. Exhaust Ducts:

1. General Exhaust System Ducts:

a. Pressure Class: Negative 2-inch wg.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

F. Liner:

1. Outside Air and Relief Air Plenums: Fibrous glass, Type I or Flexible elastomeric 2 inches thick.

G. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1-1/2 inches thick.

H. Elbow Configuration:

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

    a. Velocity 1000 fpm or Lower:

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

    b. Velocity 1000 to 1500 fpm:

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

    c. Velocity 1500 fpm or Higher:

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

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

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

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

        1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
        3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
        4) Radius-to Diameter Ratio: 1.5.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
    c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

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

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm: Conical tap.
    c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 31 19
HVAC CASINGS

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. Factory-fabricated, field-assembled, single- and double-wall casings for HVAC equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Static-Pressure Classes:

1. Upstream from Fan(s): 2-inch wg.
2. Downstream from Fan(s): 6-inch wg.

B. Acoustical Performance:

1. NRC: 1.09 according to ASTM C 423.
2. STC: 40 according to ASTM E 90.

C. Structural Performance:

1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.

a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft.

1.4 SUBMITTALS

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

1. Factory-fabricated casings.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Seismic-restraint devices.

B. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.

1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Sheet metal thickness(es).
3. Reinforcement and spacing.
4. Seam and joint construction.
5. Access doors including frames, hinges, and latches.
6. Filter, coil, humidifier, and other apparatus being installed in and mounted on casing.
7. Locations for access to internal components.
8. Hangers and supports including methods for building attachment, vibration isolation, seismic restraints, and casing attachment.
9. Interior lighting, including switches.

C. Welding certificates.

D. Product Certificates: For acoustically critical casings, from manufacturer.

1. Show sound-absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

1. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M, "Sheet Metal Welding Code," for casing joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate sizes and locations of steel supports. Supports are specified in Division 05 Section "Metal Fabrications."

C. Coordinate installation of roof curbs, equipment supports and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 GENERAL CASING FABRICATION REQUIREMENTS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 6, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."

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

1. Exterior Surface Galvanized Coating Designation: G90.
2. Interior Surface Galvanized Coating Designation:

    a. Sections Not Exposed to Moisture: G60.
    b. Sections Housing and Downstream from Cooling Coil and Humidifiers: G90 (Z275).

C. Stainless Steel: ASTM A 480, Type 304, and having a No. 2D finish.

D. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.
5. Applied Coating Color: Standard.

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

F. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.

G. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Provide shaft seals where fan shafts penetrate casing.

H. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-11, "Casing Access Doors - 2-inch wg (500 Pa)," and Figure 6.12, "Casing Access Doors - 3-10-inch wg (750-2500 Pa)"; and according to pressure class of the plenum or casing section in which access doors are to be installed.

1. Size: Minimum 20 by 66 inches height. If height of casing is less than 72 inches, then door height shall be 6 inches less than casing height.
2. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
5. Neoprene gaskets around entire perimeters of door frames.
6. Doors shall open against air pressure.

I. Condensate Drain Pans: Formed sections of Type 304, stainless-steel sheet complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches past coil.

1. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
2. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
3. Insulation: Polystyrene or polyurethane.
4. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
5. Each drain pan connection shall have a trap. Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg. Include slab height in trap calculation.

2.2 SHOP-FABRICATED CASINGS

A. Single- and Double-Wall Casings: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

B. Double-Wall Casing Inner Panel: Solid sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

C. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Coat insulation with antimicrobial coating.
3. Cover insulation with polyester film complying with UL 181, Class 1.

D. Interstitial Insulation: Flexible-elastomeric duct liner complying with ASTM C 534, Type II for sheet materials and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

E. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.

F. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use galvanized sheet steel of same thickness as casing and with a galvanized coating designation of G90.

G. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.

H. Reinforce casings with galvanized-steel angles.

2.3 MANUFACTURED CASINGS

A. Description: Double-wall, insulated, pressurized equipment casing.

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

1. Buffalo Air Handling.
2. CertainTeed Corp.; Insulation Group.
3. CLEANPAK International.
4. Industrial Noise Control, Inc.
5. McGill AirSilence LLC.
6. SEMCO Incorporated.
7. Vibro-Acoustics.

C. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and solid, galvanized sheet steel interior wall; with space between wall filled with insulation.

1. Wall Thickness: 2 inches unless noted otherwise.
2. Fabricate with a minimum number of joints.
3. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
4. Sheet metal thickness shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.
5. Sheet Metal Thicknesses:

    a. Exterior Wall Thickness: 0.040 inch minimum.
    b. Interior Wall Thickness: 0.034 inch minimum.

6. Double-Wall Casing Inner Panel: Solid sheet steel.
7. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant and vermin proof and that complies with NFPA 90A.
8. Fabricate panels with continuous tongue-and-groove or self-locking joints effective inside and outside each panel.

D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

2.4 CASING LINER

A. Fibrous-Glass Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

    a. CertainTeed Corp.; Insulation Group.
    b. Johns Manville.
    c. Knauf Insulation.
    d. Owens Corning.

2. Maximum Thermal Conductivity:

    a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
    b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to surface of the liner that will form the interior surface of casing to act as a moisture repellent and an erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

    a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible-Elastomeric Casing Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1, and with NFPA 90A or NFPA 90B.

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

    a. Aeroflex USA Inc.
    b. Armacell LLC.
    c. NOMACO Insulation.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Insulation Pins and Washers:

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

D. Shop or Factory Application of Casing Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of casing liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of casing liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of casings or cut and fit to ensure butted-edge overlapping.
5. Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 fpm.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from casing wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined casing preceding unlined duct.
    c. Upstream edges of transverse joints in casings where air velocities are higher than 2500 fpm or where indicated.

8. Secure insulation between perforated sheet metal inner wall of same thickness as specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform distance from outer wall without compressing insulation.

2.5 SEALANT MATERIALS

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

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel or stainless steel.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.

7. Mold and mildew resistant.
8. VOC: Maximum 395 g/L.
9. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel or stainless steel.

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

1. General: Single component, acid curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine concrete bases and steel supports for compliance with requirements for conditions affecting installation and performance of HVAC casings.

B. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Equipment Mounting: Install HVAC casings on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported casings, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
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.

C. Install seismic restraints on casings. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Apply sealant to joints, connections, and mountings.

E. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Support casings on floor or foundation system. Secure and seal to base.

G. Support components rigidly with ties, braces, brackets, seismic restraints, and anchors of types that will maintain housing shape and prevent buckling.

H. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

B. HVAC casings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 CLEANING

A. Comply with in Division 23 Section "Metal Ducts."

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Fire dampers.
5. Ceiling dampers.
6. Smoke dampers.
7. Combination fire and smoke dampers.
8. Flange connectors.
9. Duct silencers.
10. Turning vanes.
11. Remote damper operators.
12. Duct-mounted access doors.
13. Flexible connectors.
14. Flexible ducts.
15. Duct security bars.
16. Duct accessory hardware.

B. Related Sections:

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

1.3 SUBMITTALS

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

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

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

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

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

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

D. Source quality-control reports.

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

1.4 QUALITY ASSURANCE

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

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

1.5 EXTRA MATERIALS

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

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed, but not less than two.

PART 2 - PRODUCTS

2.1 MATERIALS

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

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

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

C. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2 finish for concealed ducts and D4 finish for exposed ducts.

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

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

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

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

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. Ruskin Company.
7. SEMCO Incorporated.
8. Vent Products Company, Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Frame: 0.052-inch-thick, galvanized sheet steel/0.063-inch-thick extruded aluminum/0.052-inch, with welded corners and mounting flange.

E. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum/0.050-inch-thick aluminum sheet with sealed edges.

F. Blade Action: Parallel.

G. Blade Seals: Extruded vinyl, mechanically locked.

H. Blade Axles:

1. Material: Nonferrous metal or galvanized steel.
2. Diameter: 0.20 inch.

I. Tie Bars and Brackets: Aluminum.

J. Return Spring: Adjustable tension.

K. Bearings: Steel ball or synthetic pivot bushings.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
    a. Sleeve Thickness: 20-gage minimum.
    b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Insect.
9. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. Ruskin Company.
7. SEMCO Incorporated.
8. Vent Products Company, Inc.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm.

D. Frame: 0.064-inch-thick, galvanized sheet steel/0.063-inch-thick extruded aluminum, with welded corners and mounting flange.

E. Blades:

1. Multiple, 0.025-inch-thick, roll-formed aluminum/0.050-inch-thick aluminum sheet.
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

F. Blade Seals: Vinyl.

G. Blade Axles: Galvanized steel or Nonferrous metal.

H. Tie Bars and Brackets:

1. Material: Aluminum.
2. Rattle free with 90-degree stop.

I. Return Spring: Adjustable tension.

J. Bearings: Synthetic.

K. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. McGill AirFlow LLC.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Ruskin Company.
g. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness, or 0.10 inch aluminum sheet channels.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.064 inch thick, or roll-formed aluminum 0.10 inch thick.

6. Blade Axles: Galvanized steel or nonferrous metal.
7. Bearings:

a. Molded synthetic or Stainless-steel sleeve.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel/Aluminum.

2.5 FIRE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. METALAIRE, Inc.
7. Nailor Industries Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 inch thick and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 CEILING DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. McGill AirFlow LLC.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Ruskin Company.
7. Vent Products Company, Inc.

B. General Requirements:

1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

F. Fire Rating: 2 hours.

2.7 SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: Modulating or two-position action.

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

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 24V, single phase, 60 Hz.

K. Accessories:

1. Momentary test switch, damper mounted.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Type: Static and dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

G. Smoke Detector: Integral, factory wired for single-point connection.

H. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Leakage: Class I.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

L. Damper Motors: Modulating or two-position action.

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

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 24V, single phase, 60 Hz.

N. Accessories:

1. Momentary test switch, damper mounted.

2.9 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.10 DUCT SILENCERS

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

1. Industrial Noise Control, Inc.
2. McGill AirFlow LLC.
3. Ruskin Company.
4. Vibro-Acoustics.

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

C. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A 653, G90, galvanized sheet steel, 0.034 inch thick.

E. Round Silencer Outer Casing: ASTM A 653, G90, galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.052 inch thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

F. Inner Casing and Baffles: ASTM A 653, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

G. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss to achieve STC 45.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Dissipative type with fill material.

    a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
    b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: Mylar.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Lock form and seal or continuously weld joints.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.

L. Source Quality Control: Test according to ASTM E 477.

1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

M. Capacities and Characteristics as indicated on drawings.

2.11 TURNING VANES

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.12 DUCT-MOUNTED ACCESS DOORS

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

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.
6. McGill AirFlow LLC.
7. Nailor Industries Inc.

8. Ventfabrics, Inc.
9. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

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

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

   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.13 DUCT ACCESS PANEL ASSEMBLIES

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

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

B. Labeled according to UL 1978 by an NRTL.

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

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

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

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

2.14 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

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

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

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

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

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz./sq. yd.
2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.15 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Thermaflex.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

C. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

D. Noninsulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 100 to plus 435 deg F.

E. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

F. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1-2004.

G. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

H. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.
2. Non-Clamp Connectors: Liquid adhesive plus tape.

2.16 DUCT SECURITY BARS

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

1. Carnes.
2. KEES, Inc.
3. Lloyd Industries, Inc.
4. Metal Form Manufacturing, Inc.
5. Price Industries.

B. Description: Field- or factory-fabricated and field-installed duct security bars.

C. Configuration:

1. Frame: 10 gage by 2 inches.
2. Sleeve: 3/16-inch, continuously welded steel frames with 1-by-1-by-3/16-inch angle frame factory welded to 1 end, furnished loose for field welding on other end. To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
3. Horizontal Bars: 1/2 inch.
4. Vertical Bars: 1/2 inch.
5. Bar Spacing: 6 inches.
6. Mounting: Metal deck or roofing, Bolted or welded with masonry anchors, Bar extends 6 inches into wall.

2.17 DUCT ACCESSORY HARDWARE

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

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

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

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

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch-diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.

I. Connect ducts to duct silencers rigidly.

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

1. On both sides of duct coils.
2. Upstream and downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream and downstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

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

L. Access Door Sizes:

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

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

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

Q. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

R. Connect flexible ducts to metal ducts with draw bands and adhesive plus sheet metal screws. Do not use flexible ducts through walls, partitions.

S. Install duct test holes where required for testing and balancing purposes.

T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 33 20

AIRFLOW MEASURING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes airflow measuring devices located in the inlet of fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations.

1.4 SUBMITTALS

A. Product Data: Include rated capacities and accessories for each type of product indicated and include the following:

1. Certified curves for the specific fan installation.

B. Coordination Drawings: Show device layout and relationships with fan inlets.

C. Maintenance Data: For airflow measuring devices to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

A. AMCA Compliance: Products shall be calibrated in the AMCA Accredited Laboratory for the application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver devices to the air handling unit manufacturer for installation in the factory.

1.7 COORDINATION

A. Coordinate size and location of attachment with fan inlet.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Temflo; Temtrol Division.
2. Piezometer Ring; Twin City Fan and Blower.

2.2 AIRFLOW MEASURING DEVICES

A. Airflow measuring device shall consist of an array of differential pressure flow sensors mounted at opposing 90° positions around the inlet of the fan.

B. Flow sensors shall be manifolded together with pneumatic tubing to form a piezometric ring.

C. Each fan assembly and airflow measuring device shall have been tested for airflow vs. differential pressure and calibrated in an AMCA Accredited Laboratory throughout the fans range of operation.

D. Airflow measuring device shall not obstruct the fan inlet, be directly mounted across the fan inlet or have any effect on fan air performance or sound power levels.

E. Airflow measuring device shall be provided with extended differential pressure tubes for connection to field supplied DDC control system with pneumatic inputs.

F. The airflow measuring device shall have accuracy of $\pm$ 2% over full span and temperature compensated from 25°F to 150°F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install airflow measuring devices at the inlet of fans.

3.2 CONNECTIONS

A. Connect airflow measuring devices to control system. Refer to Division 23 Section “Instrumentation and Control for HVAC” for sequence of controls.

3.3 FIELD QUALITY CONTROL

A. Test and adjust devices for proper operation. Verify operation the certified performance curves. Replace damaged and malfunctioning devices and equipment.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

3.4 CLEANING

A. On completion of installation, clean probes according to manufacturer's written instructions. Remove foreign material and construction debris.

END OF SECTION

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Utility set fans.
2. Centrifugal roof ventilators.
3. Axial roof ventilators.
4. Upblast propeller roof exhaust fans.
5. Centrifugal wall ventilators.
6. Ceiling-mounting ventilators.
7. In-line centrifugal fans.
8. Propeller fans.
9. Ceiling-mounting ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

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

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

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

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

D. Field quality-control test reports.

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

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

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

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 EXTRA MATERIALS

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

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Aerovent; a Twin City Fan Company.
2. Bayley Fans; a division of Lau Industries, Inc.
3. Greenheck Fan Corp.
4. Industrial Air; a division of Lau Industries, Inc.
5. JencoFan; Div. of Breidert Air Products.
6. Loren Cook Company.
7. New York Blower Company (The).
8. Penn Ventilation.

2.2 UTILITY SET FANS

A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel or Aluminum.
2. Blade Type: As scheduled.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.

2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
8. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

H. Coatings: Epoxy/Phenolic/Powder-baked enamel as indicated.

I. Capacities and Characteristics as indicated on drawings.

2.3 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 18 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares, where indicated.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Vented Curb: Unlined with louvered vents in vertical sides.

G. Capacities and Characteristics as indicated on drawings.

2.4 AXIAL ROOF VENTILATORS

A. Description: Direct- or belt-driven axial fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheel: Aluminum or Steel hub and blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 18 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.

6. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares where indicated.
7. Mounting Pedestal: Galvanized steel with removable access panel.

G. Capacities and Characteristics as indicated on drawings.

2.5 UPBLAST PROPELLER ROOF EXHAUST FANS

A. Description: Direct- or belt-driven propeller fans consisting of housing, wheel, butterfly-type discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Wind Band, Fan Housing, and Base: Reinforced and braced galvanized steel or aluminum, containing galvanized-steel or aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

1. Damper Rods: Steel with nylon bearings.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing; weatherproof housing of same material as fan housing with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 18 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares where indicated.
7. Mounting Pedestal: Galvanized steel with removable access panel.

F. Capacities and Characteristics as indicated on drawings.

2.6 CENTRIFUGAL WALL VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; Venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.

F. Capacities and Characteristics as indicated on drawings.

2.7 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

F. Capacities and Characteristics as indicated on drawings.

2.8 PROPELLER FANS

A. Description: Belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

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

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.4.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

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

E. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

F. Capacities and Characteristics as indicated on drawings.

2.9 CEILING-MOUNTING VENTILATORS

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

1. Breidert Air Products.
2. Broan Mfg. Co., Inc.
3. Dayton Electric Manufacturing Co.; a division of W. W. Grainger, Inc.
4. Greenheck.
5. JencoFan; Div. of Breidert Air Products.
6. Loren Cook Company.
7. NuTone Inc.
8. Penn Ventilation.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Plastic or Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Filter: Washable aluminum to fit between fan and grille.
6. Isolation: Rubber-in-shear vibration isolators.
7. Manufacturer's standard roof jack or wall cap, and transition fittings.

H. Capacities and Characteristics as indicated on drawings:

2.10 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Totally enclosed, fan cooled.

2.11 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

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

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

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

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

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

G. Install units with clearances for service and maintenance.

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

3.2 CONNECTIONS

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

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

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

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

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

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

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

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

E. Lubricate bearings.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Shutoff, single-duct air terminal units.

1.3 SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Isolation room air flow systems.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

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

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.4 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 Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.5 EXTRA MATERIALS

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

1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 TERMINAL UNIT MANUFACTURERS

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

1. Price Industries.
2. Titus.
3. Tuttle & Bailey.

2.2 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: 0.034-inch steel, single wall.

1. Casing Lining: Adhesive attached, 1/2-inch-thick, polyurethane foam fiber-free insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

D. Attenuator Section: 0.034-inch steel sheet, 36” long. Attenuator section shall be provided only for units specifically indicated on drawings.

1. Lining: Adhesive attached, 1-inch-thick, polyurethane foam fiber-free insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

F. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

1. Access door interlocked disconnect switch.
2. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
3. Nickel chrome 80/20 heating elements.
4. Airflow switch for proof of airflow.
5. Fan interlock contacts.
6. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
7. Mercury contactors.
8. Pneumatic-electric switches and relays.
9. Magnetic contactor for each step of control (for three-phase coils).

G. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

1. Damper Actuator: 24 V, powered closed, spring return open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

H. Control Sequence:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
2. System-powered, wall-mounted thermostat.

2.3 HANGERS AND SUPPORTS

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

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

C. Steel Cables: Galvanized steel complying with ASTM A 603.

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

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

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

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

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

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

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts." and Division 23 Section "Nonmetal Ducts."

D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils 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 motor rotation and unit operation.

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

D. Air terminal unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

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. Rectangular and square ceiling diffusers.
2. Perforated diffusers.
3. Louver face diffusers.
4. Fixed face registers and grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

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

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

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

1. Anemostat Products; a Mestek company.
2. Carnes.
3. Krueger.
4. METALAIRE, Inc.
5. Price Industries.
6. Titus.
7. Tuttle & Bailey.

B. Rectangular and Square Ceiling Diffusers:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white unless noted otherwise.
4. Face Size: 24 by 24 inches or 12 by 12 inches.
5. Face Style: Minimum three cone.
6. Mounting: To match ceiling type.
7. Pattern: Adjustable.
8. Accessories:

    a. Equalizing grid.
    b. Sectorizing baffles.

C. Louver Face Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white unless noted otherwise.
4. Face Size: As indicated on drawings.
5. Mounting: To match ceiling type.
6. Pattern: Adjustable core style.
7. Accessories:

    a. Adjustable pattern vanes.
    b. Equalizing grid.
    c. Sectorizing baffles.
    d. Operating rod extension.

2.2 REGISTERS AND GRILLES

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

1. Anemostat Products; a Mestek company.
2. Carnes.
3. Krueger.

4. METALAIRE, Inc.
5. Price Industries.
6. Titus.
7. Tuttle & Bailey.

B. Adjustable Bar Register and Grille:

1. Material: Steel or Aluminum.
2. Finish: Baked enamel, white unless noted otherwise.
3. Face Blade Arrangement: Horizontal adjustable.
4. Core Construction: Integral.
5. Rear-Blade Arrangement: Vertical adjustable.
6. Frame: 1 inch wide.
7. Mounting: Countersunk screw.
8. Damper Type: Adjustable opposed blade for register only.
9. Accessories:

    a. Front-blade gang operator.

C. Security Register and Grille:

1. Security Level: Medium and suicide deterrent.
2. Material: Steel.
3. Material Thickness: 0.19 inch unless noted otherwise.
4. Finish: Baked enamel, white.
5. Face Arrangement:

    a. Design: Fixed bar.
    b. Frame: Yes.
    c. 1-1/2-inch bars and mandrel tubes and rods with zero-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch angle border.

6. Damper Type: Adjustable opposed blade for resister only.
7. Wall Sleeve: 3/16 inch welded to face.
8. Mounting: 1-1/4-by-1-1/4-by-3/16-inch cast-in-place frame and tamperproof machine screws.

D. Fixed Face Register:

1. Material: Steel or Aluminum.
2. Finish: Baked enamel, white unless noted otherwise.
3. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid.
4. Core Construction: Integral.
5. Frame: 1 inch wide.
6. Mounting: Countersunk screw.
7. Damper Type: Adjustable opposed blade for register only.
8. Accessory: Filter.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 37 23

LOUVERS

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 also includes fixed extruded aluminum louvers and wall vents.

B. Related Sections include the following:

1. Division 23 Section "HVAC Power Ventilators" for roof-mounting exhaust fans.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Vertical Louver: Louver with vertical blades; i.e., the axes of

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Storm-Resistant Louver: Louver that provided specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of gravity loads, wind loads, seismic loads, and thermal movements without permanent deformation of components, noise or metal fatigue, or permanent damage to fasteners and anchors.

B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1-2004.

C. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range): 120 deg F ambient; 180 deg F material surfaces.

E. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.

C. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which roof curbs and ventilators will be attached.
2. Sizes and locations of roof openings.

D. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.
3. Wiring Diagrams: For power, signal, and control wiring for motorized adjustable louvers.

E. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain ventilators, louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics

are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators, louvers, vents and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2, "Structural Welding Code--Aluminum."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."
3. AWS D1.6, “Structural Welding Code--Stainless Steel.”

E. SMACNA Standard: Comply with recommendations in SMACNA’s “Architectural Sheet Metal Manual” for fabrication, construction details, and installation procedures.

1.7 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

B. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A 653, G90 zinc coating, mill phosphatized.

D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat-head screws for exposed fasteners, unless otherwise indicated.
3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
4. For fastening stainless steel, use 300 series stainless-steel fasteners.
5. For color-finished louvers, use fasteners with heads that match color of louvers.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

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

2.3 FABRICATION, GENERAL

A. Factory or shop fabricate intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases and sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

F. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

G. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolts assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.

H. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

I. Include supports, anchorages, and accessories required for complete assembly.

J. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.

1. Full Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
4. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.

K. Provide subsills made of same material as louvers or extended sills for recessed louvers.

L. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary

2.4 FIXED, EXTRUDED-ALUMINUM LOUVERS

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

1. Air Balance Inc.; a Mestek company.
2. American Warming and Ventilating, Inc.; a Mestek company.
3. Construction Specialties, Inc.
4. Greenheck Fan Corporation.
5. Industrial Louvers, Inc.
6. NCA Manufacturing, Inc.
7. Reliable Products, Inc.
8. Ruskin Company; Tomkins PLC.

B. Storm-Resistant Louver:

1. Louver Depth: Minimum 4 inches.
2. Frame and Blade Nominal Thickness: Not less than 0.080 inch for blades and 0.080 inch for frames.

3. Louver Performance Ratings:

a. Free Area: Not less than 8.0 sq. ft. for 48-inch- wide by 48-inch high louver.
b. Air Performance: Not more than 0.125-inch wg static pressure drop at 1000-fpm free area velocity.
c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a free-area intake velocity of 1000 fpm.

4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

C. Horizontal, Drainable-Blade Louver:

1. Louver Depth: 6 inches.
2. Frame and Blade Nominal Thickness: Not less than 0.080 inch for blades and 0.080 inch for frames.
3. Mullion Type: Exposed.
4. Louver Performance Ratings:

   a. Free Area: Not less than 8.5 sq. ft. for 48-inch- wide by 48-inch-high louver.
   b. Point of Beginning Water Penetration: Not less than 1000 fpm free-area velocity.
   c. Air Performance: Not more than 0.125 inch wg static pressure drop at 1000-fpm free-area velocity.

5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

D. Horizontal Nondrainable-Blade Louver:

1. Louver Depth: Minimum 2 inches.
2. Blade Profile: Plain blade without center baffle.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch for blades and 0.080 inch for frames.
4. Mullion Type: Exposed.
5. Louver Performance Ratings:

   a. Free Area: Not less than 8.5 sq. ft. for 48-inch- wide by 48-inch- high louver.
   b. Point of Beginning Water Penetration: Not less than 1000 fpm free-area velocity.
   c. Air Performance: Not more than 0.10-inch wg static pressure drop at 1000-fpm free-area velocity.

2.5 FIXED, ACOUSTICAL LOUVERS

A. Fixed, Formed-Metal Acoustical Louver: Louver with formed-metal blades filled on interior with mineral-fiber, rigid-board, acoustical insulation retained by perforated metal sheet of same material and finish a blade.

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

   a. Air Balance Inc.; a Mestek company.
   b. American Warming and Ventilating, Inc.; a Mestak company.
   c. Construction Specialties, Inc.
   d. Greenheck Fan Corporation.
   e. Industrial Louvers, Inc.
   f. Louvers & Dampers, Inc.; a division of Mestek, Inc.
   g. Metal Form Manufacturing Inc.
   h. NCA Manufacturing, Inc.
   i. Reliable Products, Inc.
   j. Ruskin Company, Tomkins PLC.

2. Louver Depth: 6 inches.

3. Frame Material: Extruded-aluminum or aluminum sheet, not less than 0.080-inch nominal thickness.
4. Frame Material: Galvanized-steel sheet, not less than 0.052-inch nominal thickness.
5. Blade Material: Aluminum sheet, not less than 0.063-inch nominal thickness.
6. Blade Material: Galvanized-steel sheet, not less than 0.034-inch nominal thickness.
7. Blade Shape: Airfoil.
8. Blade Angle: 45 degrees unless otherwise indicated.
9. Blade Spacing: 6 inches o.c. for 6-inch-deep louvers.
10. Free Area: Not less than 4 sq. ft. for 48-inch-wide by 48-inch-high louver.
11. Airborne Sound-Transmission Loss: STC 10 per ASTM E 413, determined by testing per ASTM E 90.
12. Outdoor-Indoor Sound-Transmission Loss: OITC 10 per ASTM E 1332, determined by testing per ASTM E 966.

2.6 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening except where insect screening is indicated.

B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Rewirable frames with a driven spline or insert.

2.7 BLANK-OFF PANELS

A. Uninsulated, Blank-Off Panels: Metal sheet attached to back of louver.

1. Aluminum sheet for aluminum louvers, not less than 0.050-inch nominal thickness.
2. Galvanized-steel sheet for galvanized-steel louvers, not less than 0.040-inch nominal thickness.
3. Stainless-steel sheet for stainless-steel louvers, not less than 0.038-inch nominal thickness, with grain running in same direction as grain of louver blades.
4. Panel Finish: Same type of finish applied to louvers, but black color.
5. Attach blank-off panels with sheet metal screws.

B. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: 1 inch.
2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
3. Metal Facing Sheets: Galvanized-steel sheet, not less than 0.028-inch nominal thickness.
4. Metal Facing Sheets: Stainless-steel sheet, not less than 0.031-inch nominal thickness.
5. Insulating Core: Rigid, glass-fiber-board insulation.

6. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch, with corners mitered and with same finish as panels.
7. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
8. Panel Finish: Same type of finish applied to louvers, but black color.
9. Attach blank-off panels with sheet metal screws.

2.8 FINISHES, GENERAL

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

B. Finish louvers after assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Install intake and relief ventilators, louvers, vents level, plumb, and at indicated alignment with adjacent work.

B. Secure intake and relief ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

C. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.

D. Install intake and relief ventilators with clearances for service and maintenance.

E. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.

G. Label intake and relief ventilators, louvers, vents according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

J. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

K. Form closely fitted joints with exposed connections accurately located and secured.

L. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section “Joint Sealants” for sealants applied during louver installation.

3.4 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.5 ADJUSTING AND CLEANING

A. Adjust damper linkages for proper damper operation.

B. Clean exposed surfaces of ventilators, louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore ventilators and louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with factory-applied finish coating.

END OF SECTION

SECTION 23 41 00

PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.3 DEFINITIONS

A. DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate.

B. HEPA: High-efficiency particulate air.

C. ULPA: Ultra low penetration air.

1.4 SUBMITTALS

A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ARI 850.

D. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

E. Comply with NFPA 70 for installing electrical components.

F. Comply with NFPA 90A and NFPA 90B.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 EXTRA MATERIALS

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

1. Provide one complete set of filters for each filter bank. If system includes prefilters, provide only prefilters.
2. Provide one container of red oil for inclined manometer filter gage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Air Filters, Electrostatic Air Cleaners, and Filter-Holding Systems:

a. AAF International.
b. Filtration Group.
c. CRS Industries, Inc.; CosaTron Div.
d. Farr Co.
e. Flanders/CSC Corp.
f. Flanders Filters, Inc.
g. Koch Filter Corporation.
h. NiCon Filter Corp.; Continental Air Filter Div.
i. Purafil, Inc.
j. Research Products Corp.

2. Filter Gages:

a. Airguard Industries, Inc.
b. Dwyer Instruments, Inc.

2.2 DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with holding frames.

B. Media: Interlaced glass fibers sprayed with nonflammable adhesive and anti-microbial agent.

C. Frame: Cardboard frame with perforated metal retainer.

D. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.3 EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated MERV 8, dry, extended-surface filters with holding frames.

B. Media: Fibrous material formed into deep-V-shaped pleats with anti-microbial agent and held by self-supporting wire grid.

C. Media and Media-Grid Frame: Nonflammable cardboard or Galvanized steel.

D. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

2.4 EXTENDED-SURFACE, NONSUPPORTED-MEDIA FILTERS

A. Description: Factory-fabricated MERV 8, dry, extended-surface, self-supporting filters with holding frames.

B. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and anti-microbial agent.

C. Filter-Media Frame: Galvanized steel or Hard polyurethane foam.

D. Duct-Mounting Frames: Welded galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

2.5 HIGH-EFFICIENCY FILTERS

A. Description: Factory-fabricated 12” deep, MERV 16 rated filters with holding casing.

B. Media: UL 586, fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators.

C. Frame Material: 3/4-inch- Galvanized steel or Aluminized steel.

D. Media to Frame Side Bond: Polyurethane foam/Neoprene adhesive.

E. Face Gasket: Neoprene expanded rubber.

F. Duct-Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

2.6 FRONT- AND REAR-ACCESS FILTER FRAMES

A. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters prevent deflection of horizontal members without interfering with either filter installation or operation.

B. Prefilters: Incorporate a separate track, removable from front or back.

C. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

2.7 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct system.

B. Prefilters: Integral tracks to accommodate 2-inch disposable or washable filters.

C. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from either access door.

D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.8 FILTER GAGES

A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: 4-1/2 inches.
2. Range: 0- to 1.0-inch wg or 0- to 2.0-inch wg based on filter type.

B. Manometer-Type Filter Gage: Molded plastic with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg, and accurate within 3 percent of full scale range.

C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filter frames according to manufacturer's written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Install filter gage for each filter bank.

E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling unit installations.

G. Electrical wiring and connections are specified in Division 26 Sections.

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

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components, filter and filter-frame installation, and electrical wiring, and to assist in field testing. Report results in writing.

B. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg or to design operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 23 73 15

CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes constant-volume or variable air volume, modular custom air-handling units with coils for indoor installations.

B. Related Sections include the following:

1. Division 23 Section "Humidifiers" for steam grid and evaporative humidifiers not an integral part of modular indoor air-handling units specified in this Section.

1.3 SUBMITTALS

A. Product Data: For each type of modular indoor custom air-handling unit indicated. Include the following:

1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Modular indoor air-handling units, accessories, and components will withstand seismic forces defined in Division 23 Section "Mechanical Vibration and Seismic Controls." Include the following:

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 and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

E. Field Quality-Control Test Reports: From manufacturer.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor custom air-handling units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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. NFPA Compliance: Modular indoor custom air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

E. ARI Certification: Custom air-handling units shall be listed and labeled by ETL.

F. 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 in Division 3.

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

1.6 EXTRA MATERIALS

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

1. Filters: One set for each modular indoor custom air-handling unit.
2. Fan Belts: One set for each modular indoor custom air-handling unit fan.
3. Motor Pulley: One cast iron pulley.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by CES Group Inc.; Temtrol Division.

2.2 MANUFACTURED UNITS

A. Modular indoor custom air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, dampers, plenums, filters, condensate pans, mixing dampers, air blenders, control devices, and accessories. Units shall be shipped in sections, if necessary, to accommodate smaller existing or new building openings.

2.3 CABINET

A. Materials: Welded frame, formed and reinforced double-wall insulated panels housed in 16G galvanized steel enclosure reinforced with galvanized steel angles, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

1. Outside Casing: Galvanized steel, 16G/Stainless steel, 16G.
2. Inside Casing: Galvanized steel, 20G/Stainless steel, 20G, perforated in fan section and solid in all other sections.
3. Floor Plate: Galvanized steel, 16G/Stainless steel, 16G. Single wall floors with glued insulation not acceptable.
4. Construction: All double wall panels shall be removable for outside of the unit without affecting structural integrity of the unit.

B. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.
2. Thickness: 2 inches/4 inches. Minimum density 3 lbs/cu. ft.
3. Thermal Conductivity (k-Value): 0.24 at 75 deg F mean temperature.
4. Noise Reduction Coefficient: 0.70.
5. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
6. Liner Encapsulation: All liners shall be encapsulated thick poly vapor barrier.
7. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.
8. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
9. Location and Application: Encased between outside and inside casing.

C. Access Panels and Doors: Same materials and finishes as cabinet, complete with hinges, latches, handles, and gaskets. Inspection and access panels and doors shall be double wall insulated and located to allow periodic maintenance and inspections. Doors shall not be less than 22” wide x 72” high (for units less than 6 ft. tall, door height shall be 6” less than unit hanger). Doors and panels shall be designed to open against pressure. Provide access panels and doors as shown and in the following locations:

1. Fan Section: Door on each side.
2. Access Section: Door.
3. Coil Section: Door on each side.
4. Mixing Section: Door.
5. Filter Section: Door to allow periodic removal and installation of filters.
6. Humidifier Section: Door.
7. Unit Discharge Section: Panel.

D. Condensate Drain Pans: Formed sections of 16G 304 stainless steel sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil. Drain pans shall extend full length and depth of section.

1. Double-Wall Construction: Fill space between walls with 1 inch thick 6 lbs. density fiberglass insulation and seal moisture tight.
2. Drain Connections: Both ends of pan, for units wider than 95 inches. Connection shall be minimum 1-1/4 inches MPS stainless steel.
3. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.

2.4 FANWALL TECHNOLOGY 2.0 (FWT 2.0)

A. The Fanwall Technology (FWT) array system, as manufactured by Temtrol, shall consist of multiple, direct drive, arrangement 4 plenum fans with fan wheels that are rated and certified with tests and procedures in accordance with AMCA publication 211 and comply with the requirements of the AMCA Certified Ratings Program and constructed per the AMCA requirements for the duty specified, (Class III). All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The Fanwall array shall be selected to operate at a system Total Static Pressure (TSP) that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include a 10 gauge, G 90 galvanized steel intake wall, 0.100 spun aluminum fan inlet funnel, and a 7 gauge HR steel (painted) motor support plate rail and structure. All motors shall be standard foot mounted type, TEAO motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor as approved by Temtrol for use in multiple fan arrays that operate at varying synchronous speeds as driven by a Temtrol approved variable frequency drive(s) (VFD) that have been tested and approved for use with Fanwall Technology. Steel cased motors and/or ODP motors are not acceptable. Six pole motors, unless specifically called for will not be accepted. All motors shall include permanently sealed bearings and AEGIS SGR, shaft grounding system, to protect the motor bearings from electrical discharge machining due to stray shaft currents. Motors sizes that are larger than 215 T-frame are not acceptable.

B. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed an equivalent Grade G.55, indicating a maximum of 0.03" per second peak, filter (0.55mm per second peak, filter in) residual unbalance. Arrangement 4 fans with open spring isolators that do not meet this balance specification are <u>not</u> acceptable.

C. Each "cube" (cell) in the FWT array shall be provided with Coplanar Silencer® that reduces the bare fan discharge sound power levels by a minimum of 10 db throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000 and 8000 HZ when compared to the same unit without the acoustical silencers. Coplaner Silencer® silencers do

not increase the fan total static pressure and do not increase the airway tunnel length of the air handling unit when compared to the same FWT unit without Coplanar Silencers®.

1. List or alternate manufactures, that are not Basis of Design, using arrangement 4 fans without 4-sided acoustical silencers surrounding the fan motor / wheel assembly must submit acoustical data for review and approval prior to the bid indicating that the proposed equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection location, unit dimensions, unit weights, acoustical performance, number of fans in each fan array, scheduled / specified fan BHP, scheduled / specified total fan HP for each fan array, scheduled / specified total VFD rated amps or electrical service sizing, including standby generation systems. Proposals submitted which indicate a higher connected electrical service sizing for each fan array than specified or scheduled will not be accepted.

D. The fan array shall consist of multiple fan / motor “cubes” or “cells”, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. The fan “cube” dimensions must be variable, such that each fan resets in an identically sized cube or cell. There shall be no blank off plates or “spacers” between adjacent fan columns or rows to position fans across the airway tunnel. The fan array shall provide, as a minimum, the quantity of fans scheduled or shown on the plans, in order to produce a uniform air flow profile and fan velocity profile within the airway tunnel of the air handling unit.

1. The Fanwall array shall product a uniform air flow profile and velocity within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12” from the intake side of the Fan wall array intake plenum wall, and at a distance of 48” from the discharge side of the Fan wall intake plenum wall.

E. Each fan/motor assembly in the fan array shall be removable through an access door located on the discharge (outlet) side of the fan array without requiring the disassembly of the unit and / or the removal of any wall or roof panels.

F. Each Temtrol Fan wall fan/motor “cube” will be provided with an individual backdraft damper. Temtrol Fanwall backdraft dampers (FBD) are constructed from heavy duty 6063-T5 extruded aluminum frames and blades, steel frames and blades are not acceptable. FBD have been integrated with the fan array inlet cones, wheels and “cube” geometry to achieve Near Zero System Effect Pressure Loss for Fanwall fan arrays, while enhancing the acoustic performance. Fanwall backdraft dampers have been thoroughly tested and the negligible System Effect Pressure Loss is accounted for in the Fanwall selection performance data for the specific fan wheel geometry, CFM and Total Static Pressure (TSP) conditions. FBD edge seals are solid rubber, achieving ultra low leakage rate of only 2 CFM/sq. ft. at 1” differential static pressure. Bearings are rubber shielded radial ball bearings, permanently lubricated. The vertical blades of the damper open as airflow commences and close when the fan is idle. This is accomplished without the use of mechanical means or weights.

1. Listed or alternate manufactures, other than the Basis of Design, shall provide each individual fan/motor in a multiple fan array with an integral backflow prevention device that prohibits recirculation of air in the event of fan or multiple fans become disabled. System Effect Pressure Losses for alternate backflow prevention device systems shall be identified and <u>added</u> to the scheduled design criteria for Total Static Pressure (TSP) for the alternate fan selection and performance. The <u>added</u> System Effect Pressure Loss shall be included as a separate line item SP loss in the fan performance data.
2. Backdraft damper pressure drops that area rated for pressure drop and performance in straight runs of ductwork per AMCA standards will <u>not</u> be accepted as indicating

performance for backflow prevention in the multiple fan arrays unless the damper are installed in accordance with the mounting arrangement under which the dampers are rated by AMCA for pressure loss at a given flow. Manufacturers proposing such dampers shall provide factory witnessed testing of the dampers in the proposed mounting arrangement including the fan(s) being isolated to validate the submitted pressure drops as well as the submitted fan BHP and the submitted air handling unit sound power levels. Any increase in fan system power requirements or sound power levels that exceed those as specified will be corrected at no additional cost to the Owner. Corrections for both fan power and sound power levels shall be determined and submitted to the engineer for approval prior to release for production of the submitted equipment.

3. Motorized control dampers for the purpose of backflow prevention are not acceptable. Testing of System Effect Pressure Drops for control dampers, including those with airfloil blades, mounted at fan inlets have shown airfoil control dampers create System Effect Pressure Losses similar to backdraft dampers. Motorized control dampers increase system complexity and costs to wire, control and maintain actuators. Failures of actuators, linkages or controls could result in catastrophic failures, such as damper failures, or overloading fans/motors, particularly in higher Total Static Pressure applications. Instantaneous damper closures (e.g. damper linkage or shaft failures) would result in transient pressure increases of >50% over design static pressures, potentially leading to damper failure with damper components entering the fan.

G. Each fan assembly shall be supplied with a complete flow measuring system which indicates airflow in cubic feet per minute. The flow measuring system shall consist of flow measuring stations, transducers/transmitters and controller(s). The flow measuring stations shall not obstruct fan inlets and shall have no effect on fan performance (flow or static) or sound power levels. An exterior, flush-mounted, interface for each fan array shall provide a means to monitor and control the fan array and individual fans, including indication of fan and motor status, operating mode, fan array system flow rate and static pressure. A 4-20ma output control signal from the controller(s) for use by the BAS as specified elsewhere.

H. Multiple fan array performance data submitted that is based on a single fan and then scaled to indicate performance for the number of fans in the array, or where the submitted manufacturer has less than five years of experience in building multiple fan array air handling systems and/or with fewer than 10 installations of similar scope and application, will **only** be accepted upon successful factory testing for performance and sound, and such testing shall be done for every unit being submitted. At the sole discretion of the engineer, any such testing will be witnessed by the Owner and/or his representative in an AMCA certified lab for performance and sound. Prior to the testing, a testing protocol and procedure must be submitted to the engineer for approval. All testing shall be conducted in accordance with applicable industry standards and procedures as approved in writing by the engineer. Copies of the testing results, bearing the stamp of an independent registered professional mechanical engineer, as selected by the Owner, shall be submitted for approval prior to shipment of any equipment being tested. The cost for the independent engineer, when required, shall be borne by the manufacture of the submitted equipment. Upon receipt of approved testing results, the tested equipment can be released for shipment by the manufacturer.

2.5 FANWALL TECHNOLOGY 2.0 (FWT 2.0) ELECTRICAL

A. Overview:

1. Fan array (Fanwall) electrical designs shall be in accordance with the NEC, UL 508A and ETL listing.
2. Each air handling unit shall contain one or more electrical control panels consisting of a surface mounted, NEMA rated, UL listed enclosure for the application that shall include

all supply and return fan motor disconnects and overload protection, one for each fan motor in the multiple fan array, or alternate means for providing motor disconnecting capability along with overload protection as well as a single point electrical connection for the power wiring for the multiple fan array. Means for monitoring and controlling individual fan and motor status for each of the multiple fans and motors in the array shall be provided. There shall be a controller provided as an integral part of the fan system electrical panel that automatically reconfigures the number of active fans in each multiple fan array to achieve substantially peak operating efficiency for the fan array at any fan system operating point.

a. Fan System Optimization shall be achieved by enabling and disabling fans, either manually or automatically as required, in the active array while the controller varies the enabled fan operating speeds and number of enabled fans to achieve substantially peak efficiency at the concurrent system flow and pressure demands of the system. Each fan and motor assembly shall be provided with individual fan speed control to operate at the required speed as dictated by the unit panel mounted PLC controller communicating with all fan/motor assemblies in the array via an internal Modbus communication network that is factory wired.
b. The fan array system optimization controller shall be capable of operating as a stand-alone device to control the operation of each fan array. The multiple fan array control panel(s) shall be provided with the means to monitor and control individual fan and motor status, operating mode, system flow rate and fan total static pressure, as well as connected and required HP at the concurrent system flow and pressure conditions. Status shall be displayed at the unit control panel/or at the remote location of the Building Automation System (BAS) control panel and interface screens when an BAS Communication Interface is specified/scheduled. Each Fanwall 2.0 fan array includes an exterior, flush-mounted, Human Machine Interface (HIM) to allow for local monitoring and control through a 5.7” Touch Screen Display.
c. When specified and/or scheduled, a Modbus BACnet IP, BACnet MSTP or LonWorks BAS Communication Interface shall be provided by the AHU manufacturer and shall required a single interface point at each multiple fan array system control panel by the project controls contractor. Coordinate interface with each facility BAS System.
d. The AHU unit shall be completely factory-wired, requiring only field wiring of main power wiring to the line side of the main power disconnect switch of each multiple fan array, and a separate 120/60/1 power supply with disconnect switch for receptacles and light fixtures when indicated and required. The automatic fan system optimization controller and main electrical panels shall be provided by the AHU unit manufacturer, assuring single source responsibility for the fan system operation. It is the responsibility of the contractor to assure that the project controls contactor and the AHU manufacturer’s fan system optimization controls are compatible and provide the required sequence of operation.

3. Redundancy in the variable frequency drives shall be included, along with all necessary controls and devices to assure that in a fault condition for any drive, whether internal or external to the drive, the fan array shall maintain flow and pressure at the required fan operating speed at the time of the fault with no interruption in flow to the system affected. The system shall be provided with internal ground fault protection such that a ground fault in any of the motor circuits does not cause a fan array and/or system shutdown.

2.6 OUTPUT FILTERS

A. As required by electrical design when using Variable Frequency Drives where distance and filtering is an issue, provide output line reactors as specified and/or scheduled for the multiple fan arrays. Size output filter(s) accordingly to manufacturer's recommendations.

2.7 COILS

A. Coil Sections: Common or individual, insulated, stainless-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils.

B. Water Coils: Self-draining coil fabricated according to ARI 410 Cleanable coil fabricated according to ARI 410.

1. Face-and-Bypass Dampers: Extruded-aluminum blades with full-length drive rod.

    a. Arrangement: Horizontal or vertical coils.

2. Piping Connections: Threaded, on same end.
3. Tubes: Copper not less than 5/8 inch diameter and wall thickness of 0.025".
4. Fins: Aluminum 0.008" thick and spacing of not less than 8 per inch.
5. Fin and Tube Joint: Mechanical bond.
6. Headers: Cast iron with cleaning plugs and drain and air vent tappings.
7. Frames: Stainless-steel, 0.0625 inch (16G).
8. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.

    a. Working-Pressure Ratings: 200 psig, 325 deg F.

9. Source Quality Control: Test to 300 psig and to 200 psig underwater.

C. Steam Coils:

1. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 100 psig, 400 deg F.
3. Source Quality Control: Factory tested to 300 psig.
4. Tubes: ASTM B 743 copper, minimum 5/8" diameter, minimum 0.025 inch thick.
5. Fins: Aluminum, minimum 0.008 inch thick.
6. Headers: Cast iron with cleaning plugs, and drain and air vent tappings.
7. Tube Type: Single or distributing as indicated.
8. Frames: Stainless-steel channel frame, minimum 0.0625 inch (16G) thick for flanged mounting.

2.8 DAMPERS

A. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Electric specified in Division 23 Section "HVAC Instrumentation and Controls."

C. Low-Leakage, Outside-Air Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in parallel-blade arrangement with steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg. Separate dampers shall be provided for minimum outside air and modulating outside air.

D. Mixing Boxes: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

2.9 FILTER SECTION

A. Filters: Comply with NFPA 90A.

B. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.

C. Disposable Panel Pre-Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with holding frames.

1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
2. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
3. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.
4. Efficiency: MERV 8.

D. Extended-Surface, Disposable Panel High Efficiency Filters: Factory-fabricated, dry, extended-surface filters with holding frames.

1. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
2. Media and Media-Grid Frame: Galvanized steel.
3. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.
4. Efficiency: MERV 16.

E. Filter Gauges: Provide a dial type air filter gauge having proper scale adjacent to each air filter. Gauges shall be piped to inlet and leaving side of each air filter bank with aluminum or plastic tubing. Gauges shall be calibrated to indicate inches Wg loss through each filter bank. Gauges shall be securely bolted to unit housing, in a position so that they can be readily observed from floor. Range of gauges shall be 0” to 2” of water for high efficiency filters and 0” to 1” water for all other filters.

2.10 BLENDER SECTION

A. Construction: Aluminum all welded.

B. Performance: Guaranteed to prevent air stratification when installed per manufacturer’s recommendations. Pressure drop not to exceed 0.25” Wg.

2.11 ACCESSORIES

A. Each modular indoor custom air-handling unit shall be furnished with following accessories:

1. The fan motor shall be wired to a junction box mounted on the exterior of the unit.
2. Each section shall be equipped with one vapor-proof light fixture with guard. For unit wider than 95 inches, each section shall be equipped with two vapor-proof light fixtures.
3. All lights shall be controlled by one light switch mounted adjacent to supply air fan access door.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

D. Examine the routing of getting equipment in the building. Utilize smaller sections with restricted openings in building.

3.2 INSTALLATION

A. Concrete Bases: Install floor mounting units on 6-inch-high concrete bases. See Division 23 Section "Basic Mechanical Materials and Methods" for concrete base materials and fabrication requirements.

B. Install modular indoor custom air-handling units with the following vibration and seismic-control devices. Vibration and seismic-control devices are specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

1. Floor-Mounted Units: Support on concrete bases.

C. Arrange installation of units to provide access space around modular indoor air-handling units for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to modular indoor custom air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using minimum NPS 1-1/4, Type M copper tubing. Extend to nearest floor drain or floor sink. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.

F. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam and Condensate Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

G. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

H. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

I. Ground equipment according to Division 26 Section "Grounding and Bonding."

J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set zone dampers to fully open position for each zone.
7. Set face-and-bypass dampers to full face flow.
8. Set outside- and return-air mixing dampers to minimum outside-air setting.
9. Comb coil fins for parallel orientation.
10. Install clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for modular indoor air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for modular indoor air-handling system testing, adjusting, and balancing.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

3.7 CLEANING

A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION

SECTION 23 82 16

AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of air coils that are not an integral part of air-handling units:

1. Hot-water.
2. Chilled-water.
3. Steam.

B. Related Sections include the following:

1. Division 23 Sections for air coils that are integral to air-handling units.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

D. Field quality-control test reports.

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

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 WATER COILS

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

1. Aerofin Corporation.
2. Carrier Corporation.
3. Coil Company, LLC.
4. Dunham-Bush, Inc.
5. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
6. Super Radiator Coils.
7. Trane.
8. USA Coil & Air.

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

F. Fins: Aluminum, minimum 0.006 inch thick.

G. Headers: Cast iron with cleaning plugs, and drain and air vent tappings.

H. Frames: Galvanized-steel channel frame, minimum 0.052 inch thick for flanged mounting.

I. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

J. Hot-Water Coil: Alternating arrangement of coil segments and dampers.

1. Coil Configuration: Horizontal or Vertical tubes.
2. Dampers: Extruded-aluminum blades with edge and end seals; full-length drive rod and mount for actuator outside the airstream.

K. Water Coil Capacities and Characteristics as indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless-steel drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1-2004.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section "Hydronic Piping."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 23 82 19

FAN-COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes 2-pipe and 4-pipe fan-coil units with separate water coils for heating and cooling.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of products specified.

C. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

D. Qualification date for firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of fan-coil units.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing fan-coil units similar to those indicated for this Project and that have a record of successful in-service performance.

B. Comply with ARI 440 for testing and rating units.

C. Comply with ASHRAE 33 for testing air coils.

D. Comply with NFPA 70 for components and installation.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.5 EXTRA MATERIALS

A. One (1) extra filter for each unit.

B. One (1) extra set of belts for each belt-drive unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. McQuay International.
2. Engineered Air.
3. Trane.
4. Enviro-Tec.
5. York.
6. Air-Therm.
7. International Environmental.
8. Rittling.

2.2 MATERIALS

A. Chassis: Galvanized steel with flanged edges.

B. Cabinet Insulation: Foil faced, heavy-density, ½" thick, 2 lb. density, glass-fiber insulation over entire interior of cabinet.

C. Drain Pans: Drain pans shall be stainless steel, insulated with polystyrene or polyurethane insulation. Drain pan shall be removable for cleaning. Drain pan shall extend under valve/piping package, or an auxiliary drain pan shall be provided for this purpose.

D. Cabinet: Galvanized steel with removable panels.

1. Horizontal Unit Bottom Panels: Fastened to unit with quick-open fasteners and hinge, with safety chain.

E. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on enamel, color to be selected by Architect.

F. Furnish each fan coil unit with unit-mounted 3 speed fan speed control switch.

2.3 WATER COILS

A. Fin-and-Tube Coil: ½" O.D. seamless, copper tube, with mechanically bonded aluminum fins spaced no closer than 0.08 inch (2 mm), with manual air vent. Leak test to 300 psig (2068 kPa) underwater. Coils shall be removable for service.

B. Chilled water cooling capacities are scheduled on drawings, and shall be based on 42 degrees F. EWT and 54 degrees F. LWT. Heating coils shall be in reheat position.

C. Hot water heating capacities are scheduled on drawings, and shall be based on 180 degrees F. EWT – 160 degrees F. LWT.

D. Secondary water cooling capacities are scheduled on drawings and shall be based on 51 degrees F. EWT and 61 degrees F. LWT.

E. Maximum water pressure drop through coils shall be 10 ft. water head.

2.4 FAN

A. Centrifugal fan(s), with forward-curved, double-width galvanized fan wheels, in galvanized steel fan scrolls, directly connected to motor(s). Motors shall be as specified in Division 23. Motor voltages are scheduled on drawings.

2.5 ACCESSORIES

A. Wiring Terminations: Furnish fan-coil unit with single point power connection, toggle disconnect switch, and control power transformer. Primary voltage shall match motor voltage as schedule on drawings. Connect 115 volt motor(s) to chassis wiring with plug connection.

B. Valve/Control package: Fan coil units shall be furnished for each coil (cooling and heating) complete with factory mounted cut-off valve, pressure/temperature test plug, modulating control valve and Hays 2517 fixed flow balance valve on return side and strainer, pressure/temperature test plug and cut-off valve on supply side of coil. All valves shall meet the valve specifications hereinbefore specified in the Division 23 –Valves. Units shall also be furnished with remote thermostat for heating/cooling control. Valve/piping package shall be contained within the fan-coil unit housing and shall be accessible.

1. Control valves shall be Belimo B2 series, non-spring return actuator type with chrome plated brass ball and brass stem. Provide type B3 valve where 3-way valves are noted.
2. Thermostat shall be JC Enviro-Tec nE Series or Johnson Controls digital, three-wire, modulating thermostat/controller, microprocessor based. Thermostat shall have the ability to provide pre-set limits (min. and max.) and have lockout capability.

C. Filters: 1-inch- (25-mm-) thick, pleated, or 2-inch- (50-mm-) thick, throwaway filters in fiberboard frames.

D. Condensate Overflow Switch: Each fan-coil unit shall be provided with a factory wired condensate overflow switch that shuts down the unit if a high level of water is detected in the drain pan.

E. Condensate Pump: Where scheduled, furnish and install remote condensate pump and associated piping. Large 1 gallon, ABS plastic tank condensate unit. Pump shall be a vertical-

type pump with stainless steel motor shaft, and galvanized steel tank cover. Discharge shall be ¼" FNPT or 3/8" O.D. barbed tubing adapter. Thermally protected motor shall be UL and CSA listed. Pumps shall have capacity of 130 GPH @ 20 ft. head.

PART 3 - Execution

3.1 EXAMINATION

A. Examine substrates and supports to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance of fan-coil units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units as indicated, to comply with manufacturer's written instructions and 90A.

B. Connect fan-coil units and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

C. Connect fan-coil units to hydronic piping according to Division 23 Section "Hydronic Piping." Provide shutoff valve and union or flange at each connection.

3.3 FIELD QUALITY CONTROL

A. Testing: After installing fan-coil units and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

B. Remove and replace malfunctioning units with new units, and retest.

3.4 CLEANING

A. Replace filters in each fan-coil unit.

3.5 COMMISSIONING

A. Startup Services: Engage a factory-authorized service representative to provide startup service.

B. Operate fan motor to verify proper rotation.

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

END OF SECTION

SECTION 23 82 39

UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with centrifugal fans and hot-water/steam/electric-resistance heating coils.
2. Propeller unit heaters with hot-water.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. LEED Submittal:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Details of anchorages and attachments to structure and to supported equipment.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.

5. Location and arrangement of piping valves and specialties.
6. Location and arrangement of integral controls.
7. Wiring Diagrams: Power, signal, and control wiring.

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

1. Suspended ceiling components.
2. Structural members to which unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

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

6. Perimeter moldings for exposed or partially exposed cabinets.

E. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 EXTRA MATERIALS

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

1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

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

1. Hot Water:

a. Airtherm; a Mestek Company.
b. Carrier Corporation.
c. Dunham-Bush, Inc.
d. Engineered Air Ltd.
e. International Environmental Corporation.
f. McQuay International.
g. Trane.
h. USA Coil & Air.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

1. Comply with UL 2021.

C. Coil Section Insulation: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessing Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
6. Extended Piping Compartment: Minimum 8-inch-wide piping end pocket.
7. False Back: Minimum 0.0428-inch-thick steel, finished to match cabinet.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.

F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

G. Fan and Motor Board: Removable.

1. Fan: Forward curved, high static, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

H. Factory, Hot-Water Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet and outlet.

1. Two or Three-way, modulating control valve. Three-way valve packages shall include bypass line with manually adjustable balance device.
2. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
3. Calibrated-Orifice Balancing Valves: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venture, connection for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.

I. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

J. Basic Unit Controls:

1. Wall-mounting or Unit-mounted thermostat with the following features.
2. Manual fan speed switch.

K. BAS Interface Requirements:

1. Interface shall be BAC-net or LonWorks compatible for central BAS workstation and include the following functions:

a. Cabinet unit heater start, stop, and operating status.
b. Occupied and unoccupied schedules.

L. Electrical Connection: Factory wire motors and controls for a single field connection.

M. Capacities and Characteristics as indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Suspend propeller unit heaters from structure with all-thread hanger rods. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

E. Comply with safety requirements in UL 1995.

F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

G. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam and Condensate Heating Piping."

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

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

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 84 13
HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following type of humidifiers:

1. Steam-injection humidifiers for application on ducted HVAC systems.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating weights, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, and dispersion tubes.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
2. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.

C. Maintenance Data: For humidifiers to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ARI 640, "Standard for Commercial and Industrial Humidifiers."

1.5 COORDINATION

A. Coordinate location and installation of humidifiers in ducts and air-handling units. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Steam-Injection Humidifiers:

a. Armstrong International, Inc.
b. Dri-Steem Humidifier Co.
c. Herrmidifier Co., Inc.
d. Hygromatik, Spirax Sarco, Inc.
e. Nortec Industries, Inc.
f. Pure Humidifier Co.

2.2 STEAM-INJECTION HUMIDIFIERS

A. Description: Steam valve, separator, and dispersion tube extending across entire width of duct and equipped with mounting brackets for both ends of tube.

B. Dispersion Tube: ASTM A 666, Type 304 stainless steel, jacketed.

C. Control Valve: Normally closed valve, with seat and stem matched to deliver required steam flow.

1. Actuator: As specified in Division 23 Section "HVAC Controls."

D. Steam Separator: Integral with control valve.

1. Material: Type 304 stainless steel.

E. Steam Trap: Inverted-bucket type, sized for maximum condensate flow.

F. Optional Accessories: Include the following:

1. Temperature switch to prevent cold operation.
2. In-line on-off steam control valve for automatic and total shutdown of humidifier.
3. In-line strainer.
4. Airflow switch to prevent humidifier operation when there is no airflow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

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

3.2 HUMIDIFIER INSTALLATION

A. Install with required clearance for service and maintenance.

B. Seal humidifier dispersion-tube duct penetrations with flange.

C. Install dispersion tubes pitched to drain condensate back to housing.

D. Install drip leg upstream from steam trap, a minimum of 12 inches for proper operation of trap.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to machine to allow service and maintenance.
2. Install shutoff valve and strainer in humidifier supply line.
3. Install backflow prevention device in humidifier supply line.
4. Connect piping with a minimum of 1-inch air gap in fill line to prevent backflow into supply line.

B. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 23 91 00

VARIABLE-FREQUENCY MOTOR DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for monitoring and control of motor circuits.
2. Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.3 DEFINITIONS

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFD: Variable frequency controller.

1.4 SUBMITTALS

A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFDs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

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 NFPA 70.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40 deg C.
2. Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 1000 feet.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.8 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 EXTRA MATERIALS

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

1. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Baldor Electric Company (Graham).
3. Danfoss Inc.; Danfoss Electronic Drives Div.
4. Eaton Corporation; Cutler-Hammer Products.
5. General Electric Company; GE Industrial Systems.
6. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
7. Siemens Energy and Automation; Industrial Products Division.
8. Square D.
9. Toshiba International Corporation.

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.
2. Pneumatic Signal: 3 to 15 psig.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor overtemperature fault.

H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VFC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

P. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Pneumatic Input Signal Interface: 3 to 15 psig.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

    a. 0 to 10-V dc.
    b. 0-20 or 4-20 mA.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.
    e. RS485.
    f. Keypad display for local hand operation.

4. Output Signal Interface:

    a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hz).
        2) Output current (load).
        3) DC-link voltage (VFD).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hz).

5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

    a. Motor running.
    b. Set-point speed reached.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. PID high- or low-speed limits reached.

Q. Communications: Provide an RS485 interface allowing VFD to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via BMS control. Provide capability for VFD to retain these settings within the nonvolatile memory.

R. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

S. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

T. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

U. Isolating Switch: Non-load-break switch arranged to isolate VFD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

V. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VFD).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFDs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

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

3.2 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Install VFDs on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify VFDs, components, and control wiring according to Division 23 Section "Identification for HVAC Systems."

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

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

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

DIVISION 26 - ELECTRICAL

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Coordination drawings.
6. Project record drawings.
7. TMS Asset Forms.
8. Trenching, excavating and backfilling.
9. Electrical demolition.
10. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Equipment Selection: Equipment of larger physical dimensions, higher capacities or ratings may be furnished provided such proposed equipment is approved in writing and connecting

mechanical/electrical services are appropriately modified. Any additional costs as a result of these modifications shall be borne by the Contractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery raceways in clean condition. Store to prevent entrance of dirt, debris and moisture.

B. Protect stored raceways, wires, and connectors from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.7 INTERPRETATION OF THE DRAWINGS

A. The drawings indicate diagrammatically the conduit runs and the apparatus served in a general way. No attempt has been made to show exact location of every box, fitting or conduit offset. Such items are to be provided and all wiring connections and home runs are to be made as required. Where conduit runs are shown terminating in arrows, such conduit runs shall be extended to panels/boards or other equipment. Where equipment is specified to be wired, make connections as shown on approved equipment wiring diagrams. Consult equipment approved shop drawings for location of outlets and for miscellaneous controls. Where wire sizes are shown on drawings, the wire size for each circuit shall be for the entire circuit.

B. Where conduit is shown without wiring symbols, install one (1) hot (phase) wire, one (1) neutral wire, and one (1) ground wire.

C. Provide full size neutral for each circuit.

D. No more than three circuits shall be installed in a conduit.

1.8 TEMPORARY POWER

A. The contractor shall make all provisions for and furnish and install all necessary conduit, wire, and distribution equipment for a complete temporary wiring system for use during construction of the building. Temporary wiring shall include a system of temporary lights and power distribution. Refer to Division 01.

1.9 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

E. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

F. Coordinate rough-in connections to pre-manufactured headwall systems including power for lighting, receptacles; connections for nurse call, voice/data outlets and TV interface.

1.10 SCHEDULING AND PHASING

A. All Electrical work shall be scheduled to meet project completion date. Electrical work shall be phased for projects requiring phasing of work. Install additional conduit, junction-boxes, pull-boxes, wiring devices as required to support phasing. Refer to phasing schedule on drawings.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 COORDINATION DRAWINGS

A. The contractor shall prepare CAD generated drawings (min. ¼" scale) showing following systems/items as a minimum:

1. Electrical equipment locations and clearances required.
2. Routing of main feeders and conduits (3" dia. and larger), cable trays and bus ducts.
3. Locations of items in ceiling such as light fixtures.

B. The contractor shall submit the CAD generated drawings to HVAC contractor for coordination with other trades. The drawings shall be submitted either in electronic format or printed copies as requested by HVAC contractor.

C. The contractor shall participate in coordination meetings when requested by HVAC contractor.

D. See General Conditions for additional coordination drawing requirements.

2.5 PROJECT RECORD DRAWINGS

A. See General Conditions for project record drawings requirements.

2.6 TMS ASSET FORMS

A. The Contractor shall populate and update Owner's TMS Asset forms for all areas renovated. This shall include listing information for all new equipment installed, existing equipment that is reused and deleting equipment removed during construction.

PART 3 - EXECUTION

3.1 TRENCHING, EXCAVATING AND BACKFILLING

A. Excavate to required dimensions and depth. The trench excavation shall be in open cut from surface and shall be minimum width necessary to permit the placing of the pipe as required. Excess excavation shall be backfilled with crusher run rock. Such rocks shall be placed at the Contractor's expense. Lines shall be used to lay out trenches.

B. All excavations shall be properly protected by the necessary bracing and timbers, to prevent any cave-ins or injury to adjacent improvements. The sides of the excavations shall be securely held by bracing or sheathing, which bracing or sheathing shall not be removed until the level of the backfill has reached the point where such removal can be safely carried out. Where adjacent improvements might be injured by the removal of such bracing, the braces shall be left in place to prevent such injury. The thickness of the sheathing and the dimensions of the cross braces, shoes and miscellaneous supports to be used by the Contractor shall be of type required to properly protect the sides of the trench and to prevent injurious cave-ins or erosions.

C. The Contractor shall do all pumping and bailing necessary to keep all excavations free of water and shall provide for the uninterrupted flow of the surface water adjacent to the line of the work during the progress of the work. The Contractor shall inspect the ground where excavation is required to ascertain the structure of the soil. Additional consideration will not be allowed for encountering rock, stone, old foundations or other unfavorable excavating conditions.

D. In cases where existing sewer or other piping are encountered, they shall not be displaced or disturbed. All sewer lines damaged or disturbed in the construction shall be replaced or required at the Contractor’s expense, unless, in the opinion of the Architect, such damage was caused through no fault of the Contractor.

E. Contractor shall provide all temporary steel plates, barricades, and such other signs and signals by day as shall be necessary to warn the public of and protect the workers from the danger caused by excavations and other obstructions, day and night.

F. The backfilling of trenches shall be carried out as rapidly as the testing and acceptance of the finished sections of the installation will permit. The trench shall be backfilled in layers of not to exceed eight inches (8”) with good selected clean earth, thoroughly tamped with mechanical tamper to a 95% optimum compaction. Density shall be tested by an approved laboratory, using a standard method. Tests shall be made of each 2 ft. depth on the basis of one test per 1000 sq. ft. of fill area. Last 12” of backfill shall be made with good clean top soil. Contractor shall obtain and pay for tests. Submit five (5) copies of tests for approval. Note: Broken stones, cinders, wood and rubbish are not acceptable for backfilling. Backfill all street cuts in a manner meeting the approval of the Architect.

G. In spaces between walls and line of excavation, fill with thin layers of selected clean earth; thoroughly tamp in eight inches (8”) thick layers and bring up to a finished level of established grades. All wood and foreign material shall be removed from excavation prior to backfilling.

H. After backfilling, all surplus excavated materials shall be removed from the property.

I. The work shall be executed so that any existing permanent structure along and adjacent to the new work are properly protected. Any damage occurring to these structures shall be repaired by the Contractor at his own expense.

J. The Contractor shall make field inspection of the location along which the underground conduit is to be routed, and note all obstructions and improvements at the surface which may affect the method of operation in the construction of these conduits. Such underground pipes or conduits which may exist, or which may be encountered, shall be protected by the Contractor during this construction. Any expense or inconvenience caused by their existence and the necessary protection for utilities adjacent thereto shall be considered as covered and included in the contact, without additional cost to the Owner.

3.2 ELECTRICAL DEMOLITION

A. Refer to Division 01 Section “Cutting and Patching” and Division 02 Section “Selective Demolition” for general demolition requirements and procedures.

B. Disconnect, demolish, and remove electrical systems, fixtures, devices, and components indicated to be removed. In general, remove all fixtures, raceways, cables, junction boxes, and equipment not utilized in new construction. For circuits disconnects, remove raceways and cables all way to the source. Label breakers/switches from where circuits have been removed as “SPARE”.

C. Protect existing electrical equipment and installation indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

D. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

E. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish. Raceways shall not be abandoned within walls.

F. Remove demolished material from Project site.

G. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

H. Remove equipment to be salvaged, disconnect from power, and deliver to Owner as directed.

3.3 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. In general install raceways and boxes minimum 8” above hung ceiling. All raceways, boxes and equipment shall be independently supported from structure. Do not support from ductwork or piping.

G. Where new devices are added to existing circuits, take readings prior to adding new devices, and submit to Architect for review. Do not proceed with new work until approved by Architect.

H. All low voltage devices (including but not limited to voice/data communication; nurse call; master antenna television; patient monitoring; telemetry, etc.) that are installed in patient care areas or patient rooms or procedure rooms shall have their conduit extended out to above accessible ceiling space in adjacent corridor. Terminate conduit with a bushing.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION

SECTION 26 05 05

ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:

1. Suitability of test equipment.
2. Calibration of test instruments.
3. Coordination requirements for testing and inspecting.
4. Reporting requirements for testing and inspecting.

B. Emergency systems shall be tested as specified herein.

1.3 QUALITY ASSURANCE

A. The Electrical Contractor shall completely test and inspect all systems in accordance with the specifications and drawings. The Electrical Contractor shall certify that all systems are in complete working order prior to turning over the Owner.

B. Except as modified by governing codes and by the contract documents, comply with the latest applicable provisions and latest recommendations of the following:

1. NFPA.
2. NEMA.
3. NEC.
4. IEEE.
5. IPCEA.
6. ANSI.
7. UL.
8. NECA.
9. Local Fire Department.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL TESTING

A. It shall be the responsibility of this Contractor to furnish all testing instruments/equipment, materials and labor necessary to perform the following tests.

1. After wires or cables are in place, but before being connected to devices and equipment, the system shall be tested for shorts, opens, intentional and unintentional grounds by means of wires in conduit that are shorted or unintentionally grounded shall be replaced.
2. Voltage drops for panel and large feeders shall not exceed 3% hence the total voltage drop for a feeder and any branch circuit shall not exceed 5% of the service voltage. The test shall be made under design load or it's equal.
3. Any wiring device, or electrical apparatus in this contract, if grounded or shorted on an integral "line" part, shall be removed and the problem rectified.
4. When required, complete test and inspection records shall be made and incorporated into a report for each piece of equipment tested. All readings taken shall be recorded. Four (4) copies shall be submitted to the Architect for approval.
5. Notify the Architect, with minimum seven (7) days notice, about testing schedule.

3.2 WIRING TEST

A. The wiring and cable tests shall be made before any circuits, main switches, motors, transformers or feeders are energized.

B. Tests shall be made for continuity, identification and absence of shorts and grounds for each conductor. Both ends of a given conductor shall be identified alike. Before circuit terminal connections are made, continuity and identification of wiring shall be checked by means of a DC test device using a bell, light, meter, or buzzer.

C. Insulation Resistance (IR) test shall be made using meggers at the following values:

1. 480Y/277 Volt wiring at 1000 Volts DC.
2. 208Y/120 Volt Wiring at 500 Volts DC.

D. Insulation resistance between phase conductors and neutral, phase conductors and ground shall not be less than the minimum requirements of 2000 meg-ohms.

1. Wire terminations shall not be made to equipment (motors, MCCs, but ducts, etc.), until that piece of equipment has been tested and verified as specified in this section.
2. Test motor feeders with motors disconnected, but with circuit breakers, switches or starters in the circuit opened so as to include only that portion of the feeder, required to be tested.
3. Test lighting feeders with the circuit breakers and panelboards connected but with lighting branch circuit breakers or switches open so as to include only the branch circuit to be tested.
4. Contractor shall correct or replace any circuit which is defective or grounded and shall correct all other problems encountered by these tests. All defects whether due to faulty

workmanship or material furnished by the Contractor shall be corrected under this section at the Contractor's expense.

3.3 LIGHTING TEST

A. Check all lighting fixtures for proper operation. All Contractor supplied fixtures shall be 100% operable at no additional cost to the Owner. Repair cost to Owner-supplied fixtures shall not be the responsibility of the Contractor unless otherwise stated.

B. Verify operation of Lighting Control Systems. Program time clocks per client's requirements, including holiday setbacks.

3.4 MOTOR TEST

A. Perform motor tests in coordination with fire suppression, plumbing and HVAC contractors for motors furnished with their equipment.

B. All 460-volt motors shall be individually "spot tested" for insulation resistance using 1000V DC. All 208/120V motors shall be "spot tested" with 500V DC in a similar manner. The minimum resistance to ground shall be 2000 meg-ohm (corrected to 20 degrees C). The Contractor shall record the ambient temperature of the motor and submit this value along with insulation resistance value. For motors from 7-½ to 20 HP, Contractor shall submit Dielectric Absorption Ratios. For motor above 20 HP, the Polarization Indexes of the motor shall also be submitted.

C. Make the following checks on all motors prior to start up.

1. Check motor nameplates for HP, speed, phase and voltages. Verify proper voltage available for terminal wiring.
2. Check shaft for freedom of rotation.
3. Verify that the motor is properly lubricated prior to energizing.

D. Contractor shall furnish a proper sized heater for each overload relay.

E. Make the following tests on all motors during or immediately after start-up:

1. Check for proper shaft rotation.
2. Check motor for smooth operation (vibration).
3. Take a current reading using a clamp-on ammeter. (Record no-load readings and loaded readings).

3.5 PANELBOARD, BUS DUCT AND M.C.C. TESTS

A. Test all equipment to be operated on the 480/277V system at 1000V DC and all equipment to be operated on the 208/120V system at 500V DC prior to connecting feeders. A minimum insulation resistance of 2000 meg-ohms shall be obtained between all phases and between phase and neutral, and phase and ground.

3.6 TRANSFORMER (RATED FOR 600V OR LESS) TEST

A. Insulation tests on transformers shall be as follows:

1. 480 Volt Side.

    a. Test with 1000V DC, high side winding to low side winding and high side winding to ground. 2000 meg-ohm shall be minimum acceptable insulation resistance.

2. 208/120 Volt Side.

    a. Test with 500V DC, low side to ground. 200 meg-ohm shall be the minimum acceptable insulation resistance.

3.7 SPOT TEST

A. “Spot Test” mentioned in this section shall be interpreted as the specific test method of obtaining insulation resistance by applying indicated test voltage for 60 seconds to the equipment or wiring being tested.

3.8 CONTROL WIRING/OUTLET TEST

A. Control wiring shall perform the function as noted in operation methods and/or included schematics and single line diagrams.

B. All 120-volt outlets shall be tested with a Daniel Woodhead Cat. No. 1750 and 1760 tester. Minimum acceptable tension is 10 oz. for NEMA 5-15R, and 5-20R, 6-15R, 6-20R, 7-15R, 7-20R, 14-20R, 15-15R and 15-20R receptacles.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:

1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
2. Division 26 Section "Undercarpet Electrical Power Cables" for flat cables for undercarpet installations.
3. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing

Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. All conductors and cables shall be UL labeled.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

B. Coordinate layout and installation of conductors and cables with other trades.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery conductors and cables according to NEMA WC 26.

B. Protect stored conductors and cables from moisture and dirt. Do not store outside, exposed to elements. Elevate above grade. Do not exceed structural capacity of floor, when stored inside.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of 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. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC or mineral-insulated, metal-sheathed cable, Type MI with ground wire.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell Power Systems, Inc.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M; Electrical Products Division.
6. Panduit Corporation.
7. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL AND SIZE APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Conductors smaller than No. 12 AWG shall not be utilized anywhere, unless specifically noted on drawings.

D. The minimum conductor size for branch circuits shall be #12 AWG copper. To compensate for voltage drop, where branch circuit lengths are between 100 and 150 feet, use #10 AWG copper. For branch circuit lengths exceeding 150 feet, use #8 AWG copper.

E. Wire size ampacity shall equal or exceed its overload protective device. Where wire sizes shown on the drawings are greater than the apparent ampacity requirements, the size shown shall prevail to compensate for voltage drop. In no instance shall conductors be installed that are less than required by NEC.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway or Type XHHW, single conductors in raceway. Mineral-insulated, metal-sheathed cable, Type MI where specifically indicated on drawings.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

D. Feeders at all other locations: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits at all other locations: Type THHN-THWN, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

K. Fire Alarm Circuits: Refer to Section 280513 “Conductors and Cables for Electronic Safety and Security”.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and factory color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and branch circuit 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 No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of final acceptance.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

B. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

C. Related Sections include the following:

1. Division 26 Section 260519 “Low-Voltage Electrical Power Conductors and Cables” for requirements for grounding conductors.

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn copper.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch diameter by10 feet in diameter.

2.4 DEEP EARTH GROUND

A. Furnish and install a minimum of two (2) deep earth grounding electrodes. Each electrode shall have a maximum resistance of 3 ohms. The preferred resistance is 1 ohm. The resistance of each electrode shall be measured using the 3-point fall of potential method.

B. Each electrode shall be installed to a depth as required to obtain specified resistance. Drilling for electrode shall be done in conformance with all local and national codes. Locate all site utilities prior to drilling. Furnish and install ingrade junction box at top of each electrode.

C. Submit test report of each electrode. Include with report pictures and plans indicating locations for test electrode. Submit information on test instruments used and dates of last calibrations.

D. Repair and replace any items damaged or changed in any qay due to the drilling.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a

separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Electrical Room Grounding Bus: Space 1 inch (25 mm) from wall and support from wall 6 inches (150 mm) above finished floor except as otherwise indicated.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

E. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

F. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

G. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

H. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

I. In addition to using the water service as a grounding electrode, effectively grounded building steel or rebar of reinforced concrete columns, driven ground rods outside or buried electrode shall be provided and inter connected.

J. Provide a copper ground cable from the above main service ground bus to building steel, driven ground rods outside or buried electrodes.

K. Provide a copper ground cable from the reference ground bus in the primary service room to each 480/120V transformer.

L. The Main service neutral shall be bonded to the main service ground. Main ground bars shall be 4 foot width x 12” height x ¼” thick.

M. Bond with a grounding conductor, minimum #4 copper all interior metallic water, gas and other metallic lines.

N. The complete metal conduit system shall be used for the equipment grounding system. Conduit systems and associated fittings and terminations shall be made mechanically tight to provide a continuous electrical path to ground and shall be safely grounded at all equipment by bonding all metallic conduit to the equipment enclosures with locknuts cutting thru paint of enclosures. Bond all conduits entering primary switchgear, unit substations and secondary switchboards with a ground wire connecting the grounding type bushings to the equipment ground bar. Conductors shall be sized per NEC.

O. In addition to using the conduit system for grounding, a complete auxiliary green wire equipment grounding system shall be installed, continuous from main ground, through distribution and branch circuit panelboards and paralleling all feeders and branch circuit wiring. The minimum size shall be #12 copper except #14 on control circuits. This shall apply to all circuits rated 100 volts or more above ground potential.

P. Bond all communications conduit systems to ground.

Q. Connect ground terminal on wiring devices to auxiliary green wire equipment grounding system.

R. Ground the neutral terminals of all transformers for separately derived systems. The Ground electrode shall be either of the following:

1. Building system ground bus. The ground bus must be effectively bonded to the service ground.
2. Nearest building steel or concrete column re-bar. The steel or re-bar must be effectively bonded to the service ground.
3. The street side of the main water service.
4. A set of interconnected ground rods or other NEC approved electrodes.

S. Ground the neutral terminals of all Generators for separately derived systems. The Ground electrode shall be either of the following:

1. A set of interconnected ground rods or other NEC approved electrodes.
2. Building system ground bus. The ground bus must be effectively bonded to the service ground.
3. Nearest building steel or concrete column re-bar. The steel or re-bar must be effectively bonded to the service ground.
4. The street side of the main water service.

T. Ground Generators at the following locations.

1. Generator frame.
2. Engine- generator skid.
3. Generator output circuit breaker and switchgear.
4. Automatic Transfer Switch.
5. Fuel Tanks.

U. Motor frames shall be bonded to the equipment grounding system by an independent green wire, sized as shown.

V. System neutral connections shall be insulated from metal enclosures except at the neutral of the service entrance equipment and on the neutral of a separately derived system. Connections to the main switchgear enclosure shall be by means of bonding jumpers.

W. The building neutral shall be identified throughout with white conductors. Where there are neutral conductors from a separately derived system (such as 120/208 volt, 3 phase, 4 wire where the main building service is 277/480 volt, 3 phase, 4 wire) the neutrals of the two systems shall be separately identifiable.

X. Steel frame buildings and metal exterior coverings on buildings that are not effectively grounded shall be grounded thru a low resistance grounding system whether or not a lightning protection system is required.

Y. Ground metal exterior coverings and metal roofs with minimum #4 copper conductor at a minimum of two points, intervals not exceeding 100 feet.

Z. Ground steel frame buildings at each corner with maximum of every 60 ft. around the outside perimeter by cadwelding #2/0 (#4/0 for buildings over 75 ft. tall) copper conductor to steel columns and extending below ground to driven ground rods; top of 0.625 inch x 10 ft. ground rod shall be minimum of 12 inches below finished grade and 3 ft. out from building foundation. Bond the water service, street side of water meter, to the adjacent perimeter steel column with #4/0 insulated copper conductor. Sleeve all concrete foundations and masonry walls with PVC sleeve.

AA. Metal covers on pull boxes and junction boxes shall be effectively grounded.

BB. Connections to driven ground rods or other such electrodes shall be a minimum of three feet from the foundation wall or beyond the roof drip line, whichever is greater. Do not install ground rods in backfill.

CC. The electrodes (driven ground rods) of the electrical grounding system shall not be used for the electrodes for the lightning protection system, and vice versa. However, these two systems shall be bonded together at one point.

DD. Wiring devices shall be connected with grounding jumper from ground pole on device to grounding screw in the outlet box.

EE. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building foundation.

FF. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.4 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order pf galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Complete with manufacturer’s written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to

grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal**,** and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Division 26 Section "Vibration and Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

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

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. Fabco Plastics Wholesale Limited.
d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

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.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in 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 or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch 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: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

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. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches 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. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. RNC: Rigid nonmetallic conduit.

H. RMC: Rigid metal conduit (rigid steel conduit).

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. International Metal Hose Co.
5. Manhattan/CDT/Cole-Flex.
6. Maverick Tube Corporation.
7. O-Z Gedney; a unit of General Signal.
8. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel or die-cast, set-screw or compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. CANTEX Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. Lamson & Sessions; Carlon Electrical Products.
7. Manhattan/CDT/Cole-Flex.
8. RACO; a Hubbell Company.
9. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Keystone/Rees Inc.
4. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 3R, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type. Flanged-and-gasketed type where shown on drawings.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

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

a. Thomas & Betts Corporation.
b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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

a. Butler Manufacturing Company; Walker Division.
b. Enduro Systems, Inc.; Composite Products Division.
c. Hubbell Incorporated; Wiring Device-Kellems Division.
d. Lamson & Sessions; Carlon Electrical Products.
e. Panduit Corp.
f. Walker Systems, Inc.; Wiremold Company (The).
g. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Thomas & Betts Corporation.
9. Walker Systems, Inc.; Wiremold Company (The).

B. Pull and junction boxes shall be minimum 4” x 4”.

C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

F. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic**,** finished inside with radio-frequency-resistant paint.

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.

2.6 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.7 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit or IMC or RNC, Type EPC-40-PVC.
2. Concealed Conduit, Aboveground: Rigid steel conduit or IMC or RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Within Underground Duct Banks: IMC or RNC, Type EPC-40-PVC.
5. Underground Conduit: RNC, Type EPC-40-PVC, when encased in minimum 3” thick concrete.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
7. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Electrical rooms.
    e. Stairwells.
    f. Within block or masonry walls.

3. Concealed Above Hung Ceilings and Within Interior Sheet Rock Walls and Partitions: EMT.
4. Underground Conduit: Rigid steel conduit or IMC, below concrete or within poured concrete.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations. Length not to exceed 6 ft.
6. Damp or Wet Locations: Rigid steel conduit.
7. Connection to Kitchen Equipment: LFMC/LFNC from disconnecting switch. Length not to exceed 6 ft.
8. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway or EMT.
9. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

C. Concealed: FMC ½” inch – only in specific locations, in existing areas, within existing walls to remain. Utilize only between box in wall to junction box above ceiling. Junction box shall be located within 12” above hung ceiling. FMC, within walls, not acceptable in other locations.

D. Minimum Raceway Size: 3/4-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.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

F. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

G. Install raceways underground or below floor only for locations indicated on drawings.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping. Do not install horizontal raceway directly and parallel under cold water or chilled water pipes. In general, install raceways as high as possible, closer to underside of structure. Install horizontal raceways minimum 8 inches above ceilings.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install temporary closures to prevent foreign matter entering the raceways.

F. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.

1. Use insulating bushings to protect conductors.

K. Utilize compression fittings only with suitable tools.

L. 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.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

M. 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.

N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

O. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with one (1) locknut, use two (2) locknuts: one (1) inside and one (1) outside the box.

P. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

Q. 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.

R. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

S. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

T. Expansion-Joint Fittings: Install UL approved expansion fittings in each run of aboveground conduit that is located at building expansion joint. Length of fittings shall not exceed 6 inches.

U. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit from junction boxes to recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Flexible conduit from light fixture to lighting fixture not allowed.

V. 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.

W. Set metal floor boxes level and flush with finished floor surface.

X. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

Y. All raceways terminating a junction boxes, located above ceiling shall be provided with color coded vinyl tape indicating the service. Color coding tape shall be applied next to the junction box. Tape color shall match junction box cover color.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section “Common Work Results for Electrical”.
2. Install backfill as specified in Section "Common Work Result for Electrical".
3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.7 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.8 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes. Remove burrs, dirt, and construction debris.

END OF SECTION

SECTION 26 05 36
CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Entire Division 27.

1.2 REFERENCE

A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under division 1 General Requirements.

B. ASTM A 123 – Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.

C. ASTM B 63 – Specification for Electro-Deposited Coating of Zinc on Iron and Steel.

D. DEM AVE 1 – Metallic Cable Tray.

1.3 DESCRIPTION

A. Provide complete cable tray system including straight tray sections, fittings such as horizontal elbows, vertical risers, crosses, tees, wyes, reducers and coupling accessories, splices plates and cable tray supports to support cable systems in locations as indicated on drawings.

B. Cable tray system is intended to carry telephone, data, BAS, Security CCTV and Access Control cables only; power wiring and fire alarm system cabling are not permitted.

C. Material and installation shall comply with NEMA – “WE1, Cable Tray Systems”, NEC.

1.4 DEFINITIONS

A. Static Loads: Weight of empty installed cable tray system and live cable wright after installation into Cable Tray System.

1.5 SUBMITTALS

A. Shop drawings for equipment provided under this Section.

B. In addition to requirements of Division 1, the following information shall be provided:

1. Type of tray.
2. Width, depth, length, thickness and radius of bends (where applicable).
3. Rung spacing (where applicable).
4. Cable bearing surface dimensions.
5. Material of construction and finish.
6. Longitudinal loading, deflection and design safety factors.
7. Resistance of materials and splice plates.
8. Accessories.

C. Provide shop drawing showing cable tray routing on floor plans. Show that cable tray route has been coordinated with all trades and unique features of the building. Include dimension information from column lines and include elevations above finished floor.

D. Provide as-built drawings showing floor plan location, elevation changes and conduit drops.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers: B-Line, Chalfant, Globe, Mono-Systems, Inc.

2.2 FABRICATION AND MANUFACTURER

A. Materials of Construction:

1. Materials shall be adequately protected against corrosion or made of corrosion resistant material.

B. Aluminum Trays:

1. Straight section and fitting side rails shall be extruded aluminum. Other components shall be aluminum.

C. Tray system shall be ladder type width as indicated in documents by 4” deep with minimum usable loading depth 1” less than overall nominal tray depth.

D. Ladder type trays shall consist of two (2) longitudinal members (side rails) with transverse members (rungs) welded to side rails. Tray rung spacing shall be designed to prevent cable sagging as follows:

1. Low Voltage System Cables: 6” maximum.

E. Ladder type tray rungs shall have minimum cable bearing surface of 7/8” with radiused edges. No portion of rungs shall protrude below bottom place of side rails.

F. The system shall not present sharp edges, burrs or projections injurious to wiring. Upper flanges shall be rolled out and downward for safety.

G. Provide splice plates with straight sections and fittings. Splice plates shall be bolted type. Splice plate construction shall be designed to permit splice to be located at any point within support space without diminishing cable tray rated loading capacity.

H. Splice plates for aluminum tray systems shall be aluminum and attached with minimum of 4 rib neck carriage bolts, lock washers.

I. Select splice plates to match cable tray material.

J. Supports for Aluminum Type:

1. Aluminum or painted carbon steel.

K. Minimum bending radius of cross-ties and elbows shall be 24".

L. Trapeze hangers shall be supported by ½" minimum diameter rods.

M. Cadmium plated components shall not be used in any part of cable tray system.

N. Aluminum cable trays shall be UL classified as equipment grounding conductors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tray system shall be accessible and with sufficient space provided and maintained to permit side access for installing and maintenance of cables.

B. Join cable tray system sections at ends using manufacturer prefabricated Splice Plates. Provide laminated aluminum bonding jumper at all field cut sections.

C. Provide a set of manufacturer prefabricated expansion splice plates at intervals of 48 ft. in straight runs and where cable tray systems cross building expansion joints.

D. Support cable tray system utilizing trapeze hangers from building or other structural steel members, angle brackets from vertical structural steel members, upright angle brackets on pipe racks, or directly upon horizontal structural steel members of the building or pipe racks.

E. Size, anchor, and space supports to sustain weight of cable tray system, cable and tubes which are to be installed into cable tray, and 200 lbs. excess on any individual ladder rung or section, with safety factor of 50% minimum when supported as simple span and tested per NEMA requirements. Load and safety factors are applicable to both, run or section and side rails. Calculate supports based on 100 lbs/ft load of cables and tubes.

F. Total vertical tray deflection shall not exceed 1-1/2" between supports.

G. Make intersections, bends, tees, etc. using fittings of same type and model series as straight run sections as required.

H. Cable tray systems shall be electrically continuous. Provide laminated aluminum bonding jumpers at all elevation changes.

I. Provide manufacturers full width cable drop out of all changes in elevation in horizontal runs and exits from cable tray.

J. Connect each cable tray system subassembly to building ground system using grounding clamps and grounding conductors in accordance with grounding requirements per National Electrical Code (NEC) and applicable local codes. Provide 3.0 ohm maximum resistance to building ground connection.

K. Copper grounding conductors shall be not installed on aluminum tray systems without appropriate connectors listed for the purpose.

L. Structural members shall not be punched or drilled except for splice-plate and fastener bolt holes.

M. Cable tray system components shall not be flame-cut or arc-cut. Make curs using a saw. Drill or punch holes for splice-places and fasteners and remove burrs.

N. Conductor and Innerduct Installation:

1. Provide UL listed metallic ground conduit clamps to attach conduits to cable tray system.
2. Provide bushings on conduit ends where cables or innerduct enter conduit to protect insulation or jacket.
3. Provide plastic prefabricated plenum rated closure straps (tie-wrap type) of black or opaque color for securing cables and induct in cable tray system. Ensure that cables are not nut and that innerduct is not pinched or collapsed by applying these straps too tightly or by fastening strapped grouping to another strapped grouping.
4. Cut strap ends on opposite side of rung from cables or innerduct except where back of rung is inaccessible.
5. Innerduct shall not be fastened to cable tray rungs at each rung in horizontal runs. Strapping is to be kept to 4’ minimum spacing.
6. Strap vertical runs as required to prevent sagging of cables and tubing.
7. Provide sufficient slack in cables and innerduct to allow for unequal expansion soefficients of cable tray and cables or innerduct. This requirement is in addition to slack required at cable tray expansion joints.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
2. Handholes and boxes.
3. Manholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes, and other utility structures.
4. Warning tape.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder/Step details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

E. Source quality-control test reports.

F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical and/or Communications Service: Do not interrupt electrical and/or communications 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 Architect no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations

from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. Cantex, Inc.
2. Electri-Flex Company.
3. Prime.
4. Allied.

B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems".

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

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

1. Christy Concrete Products.
2. Oldcastle Precast Group.
3. Riverton Concrete Products; a division of Cretex Companies, Inc.
4. Utility Concrete Products, LLC.
5. Utility Vault Co.
6. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC" as indicated.
4. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension shall provide increased depth of 12 inches.
    b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with most current SCTE 77 Specification For Underground Enclosure Integrity.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" as indicated.
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. All Communications Handhole Boxes and Handhole Covers on the project shall be Polymer Concrete type, unless otherwise noted or unless location of a handhole box requires AASHTO H-20 load rating for deliberate vehicular traffic.
2. Communications handhole boxes and covers shall be minimum ANSI/SCTE 77 Tier 22 rated for occasional non-deliberate heavy vehicular traffic unless location of handhole box requires AASHTO H-20 load rating for deliberate vehicular traffic, and unless otherwise required shall be the following makes and models, or approved equivalents, for sizes as indicated.

    a. 24” x 36” x 36” deep:

        1) Box: Quazite model # PG2436BA36.
        2) Cover: Quazite model # PG2436HH0012, with “COMMUNICATIONS” label.
        3) Extension: Where indicated on drawings, provide 11.5-inch tall ANSI/SCTE 77 Tier 22 rated extension for added depth.
        4) Provide on each 36-inch long interior wall, two 7-inch non-metallic cable rack arms, Underground Devices model # MM7.

3. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Quazite Corporation.
    b. Armorcast Products Company.
    c. Synertech.

2.5 PRECAST MANHOLES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Oldcastle Precast Group.
2. Christy Concrete Products.
3. Riverton Concrete Products; a division of Cretex Companies, Inc.
4. Utility Concrete Products, LLC.
5. Utility Vault Co.
6. Wausau Tile, Inc.

B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.
b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

E. Manholes shall be equipped with corrosion-resistant cable racks and permanent ladders, which are grounded; pulling irons; and a sump pit and floor drainage system to drain water.

F. Pulling irons shall be provided on opposite sides of the ducts, rated at 10,000 pounds pulling tension.

G. Cable racks shall be installed into the walls of Communications manholes:

1. Provide on each of the two longest interior walls, two 36-inch heavy duty non-metallic cable rack stanchions, Underground Devices model # CR36-B or approved equivalent.
2. Provide on each cable rack stanchion, two non-metallic 11-inch cable rack arms, Underground Devices model # RA11.

H. Sump Frame and Gate: ASTM A 48.

I. Ladder: UL-listed, hot-rolled, hot-dip galvanized steel ladder specifically designed for manhole use. Minimum length equal to the distance from the manhole floor to grade. Each manhole shall contain its own ladder.

J. Manhole lid (cover) shall be cast-iron with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts. Cover finish shall be non-skid with minimum coefficient of friction of 0.50. Cover shall not have a legend indicating type of service.

2.6 ACCESSORIES

A. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening 2-inch diameter eye and 1-1/4-inch bolt.

1. Working load Embedded in 6-inch, 4000-psi concrete: 13,000-lbf minimum tension.

B. Pulling and Lifting Irons in Floor: 7/8-inch diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

C. Bolting Inserts for Cable Rack Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4-inches deep, flared to 1-1/4-inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

D. Conduit-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg. F. Capable of withstanding temperatures of 300 deg. F. without slump and of adhering to clean surfaces of plastic conduits, metallic conduits, conduit coatings, concrete, masonry, lead cable sheaths, cable jackets, insulation materials, and common metals.

E. Conduit Duct Plugs:

1. Shall be manufactured from high impact plastic components and shall be corrosion proof.
2. Shall contain a durable elastic compressible gasket which will make duct plug effective as a long term or temporary seal.
3. Shall be removable and reusable.
4. Shall meet or exceed the following mechanical requirements:

a. Air Pressure: 7.5 psi
b. Water Head: 15 ft.
c. Pull Out: 100 Kgf.

5. Shall be equipped with a rope tie device on the back compression plate to allow the securing of a pull rope. This will allow excess rope slack to be stored within the conduit.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

E. Underground Electrical Ducts Crossing Paved Paths, Walks and Driveways or Roadways: RNC, NEMA Type EPC-80-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Communications underground enclosures, including manholes and handhole boxes, shall not be shared with electrical installations.

B. Handholes and Boxes for 600 V and Less**,** Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 22 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 22 structural load rating.

C. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17 unless otherwise indicated.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 26 Section "Trenching, Excavating and Backfilling", but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants".

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching".

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends:

1. Use 5-degree angle couplings for small changes in direction.
2. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
3. Angle couplings and manufactured bends alone or in combination with straight sections shall be used for direction changes. Direction changes make by skewing straight sections of conduits will not be permitted.

C. No section of conduit shall have more than 180 degrees of bends without a manhole or handhole installed as an access point.

D. No conduit run shall extend more than 500 feet without a manhole or handhole installed as an access point.

E. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

F. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 8 inches on center for 4-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical".

H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

I. Pulling Cord: Install minimum 200-lb-test nylon cord in ducts, including spares. A minimum of 5-feet shall be coiled and secured at each conduit end in such a manner as to prevent it from being accidentally pulled back into the duct.

J. Tracer Wire:

1. Install in a minimum of one conduit of every underground conduit run, including duct banks, an insulated, single strand, solid copper minimum 12 AWG tracer wire coated with a minimum 30-mm PE jacket designed specifically for buried use.
2. In duct banks, tracer wire shall be installed in one of center-most conduits.
3. In multi-level duct banks, tracer wire shall be installed in top-most level, in one of center-most conduits.

K. Direct-buried Ducts: Install at minimum 36-inches below grade.

L. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased electrical duct banks where they cross paved paths, walks, and driveways or roadways, and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

M. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank.
4. Install backfill as specified in Division 31 Section "Trenching, Excavating and Backfilling".
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

10. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line, below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install sump drain in bottom of manholes. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing". After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

1. Install two cable rack stanchions on each 8-foot length interior wall of Communications manholes, with stanchions spaced at 3-feet horizontal separation, centered on wall, with bottom of stanchion mounted at 15-inches from interior manhole floor. Install per manufacturer’s guidelines.
2. Install two cable rack arms on each stanchion, spaced at 16-inch vertical separation. Install per manufacturer’s guidelines.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

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 and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes of 36-inch depth or greater with bottom below the frost line, minimum 36 inches below grade.

E. 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 the enclosure.

F. Field-cut openings for ducts and 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.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screened to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Install a driven ground rod through manhole floor, close to wall, and set rod depth so 4-inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2-inches above to 6-inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level and plumb around corners and fasten to manhole walls with cable clamps secured with expansion anchors. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 26 05 48

VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Spring isolators.
3. Restrained spring isolators.
4. Channel support systems.
5. Restraint cables.
6. Hanger rod stiffeners.
7. Anchorage bushings and washers.

B. Related Sections include the following:

1. Division 26 Section "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Pads Type - A.1: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Spring Isolators - Type B.1: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators - Type B.2: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

E. Elastomeric Hangers - Type B.4: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

2.2 SEISMIC-RESTRAINT DEVICES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Cooper B-Line, Inc.; a division of Cooper Industries.
3. Hilti Inc.
4. Mason Industries.
5. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Steel Base - Type E.1: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mounting and to provide for anchor bolts and equipment support.

C. Inertia Base - Type E.2: Factory-fabricated, welded, structural-steel bases and tails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 VIBRATION ISOLATOR AND SEISMIC-RESTRAINT SCHEDULE FOR SLAB ON GRADE LOCATED EQUIPMENT

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Generator sets (with internally isolated engine and generator)	Floor	All sizes	-	A.1	0.25”
Remote Radiators	Floor	All sizes	-	A.1	0.25”
Transformers	Floor Suspended	All sizes All sizes	- -	A.1 B.4	0.25” 0.25”

Notes: 1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.

3.7 VIBRATION ISOLATOR AND SEISMIC – RESTRAINT SCHEDULE FOR EQUIPMENT LOCATED ABOVE GRADE

Equipment	Mounting	Size	Base Type	Isol. Type	Static Deflection
Generator sets (with internally isolated engine and generator)	Floor	Up to 300 KW 350 KW and higher	E.1 E.2	B.1 B.2	1.0” 1.0”
Remote Radiators	Roof	All sizes	-	B.1	1.0”
Transformers	Floor Suspended	All sizes All sizes	- -	A.1 B.4	0.25” 0.25”

Notes: 1. The table indicates minimum static deflection for the isolator. The Contractor shall provide isolators with proper deflection, for equipment furnished, as recommended by the isolator manufacturer.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. 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.
9. Ceiling Grid Labels.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 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.

1.5 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 and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: 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.

F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

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 and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. 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.

E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

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.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, 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 of Conductor Tape: All service, feeder and branch circuit conductors, rated for 600V or less shall be factory color-coded as specified herein. Field applied labels, tapes or bands not acceptable.

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.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.5 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical 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.

2.7 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 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."

2.8 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.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Minimum 0.0625 inch thick adhesive backed, with white letters on a black background. Minimum letter height shall be 3/8 inch.

B. Engraved, Laminated Acrylic or Melamine Label: Minimum 0.0625 inch thick punched or drilled for screw mounting. White letters on a black background. Minimum letter height shall be 3/8 inch.

2.10 JUNCTION/PULL BOX COVER IDENTIFICATION

A. Paint all junction and pull box covers to identify service and voltage as follows:

1. 120V Normal power – Green.
2. 120V Emergency power – Orange.
3. 277V Normal power – Blue.
4. 277V Emergency power – Yellow.

B. All covers shall identify circuit numbers, panel designation, voltage and service. Identification shall be done by black magic markers.

2.11 WALL PLATE IDENTIFICATION

A. All receptacle and switch wall plates, including plates located in head-wall systems/booms/ceiling columns etc. shall identify panelboard and circuit number from which served. Coordinate with system manufacturer for receptacle and switch wall plates located in headwall systems/booms/ceiling columns etc. Use engraved machine printing with back-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes. Self-adhesive tape with lettering not acceptable.

2.12 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.13 Miscellaneous Identification Products

A. Paint: Comply with requirements in Division 09 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.

2.14 CEILING GRID LABELS

A. Self-Adhesive Vinyl Labels for equipment above ceiling: Minimum ½" Preprinted, flexible label to match Owner's standards. Color as directed.

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, within mechanical rooms, chiller rooms and boiler rooms.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. 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.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl or Snap-around labels. Install labels at 10-foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for All Service, All Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label or self-adhesive vinyl tape applied in bands. Install labels at 20-foot maximum intervals. The identification will include source board/panel and target board/panel. Use black letters on orange background.

D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box as specified herein.

E. Power-Circuit Conductor Identification, 600 V or Less: Factory color-code conductors as listed below:

1. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White.
e. Ground: Green.
f. Switch Legs: Pink.

2. Colors for 480/277-V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Neutral: Gray with colored stripe.
    e. Ground: Green.
    f. Switch Legs: Purple.

F. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

G. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

H. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

I. 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.

J. 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.

K. 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.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels or Baked-enamel warning signs or Metal-backed, butyrate warning signs.

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.

M. 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.

N. 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.

O. 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 or 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.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label 4 inches high.
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
e. 7appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
f. Equipment served by emergency power shall be provided with labels incorporating red background and white letters. All other equipment labels shall be white letters on black background.
g. The label shall include voltage, phases, number of wires, and board/switchgear/equipment served from. (Example: Panelboard BL-20-LN; 120/208 volts, 3 phase, 4 wire, served from board DP-B1-HN).

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Switchgear.
e. Switchboards.
f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
g. Substations.
h. Emergency system boxes and enclosures.
i. Motor-control centers.
j. Enclosed switches.
k. Enclosed circuit breakers.
l. Enclosed controllers.
m. Push-button stations.
n. Power transfer equipment.
o. Contactors.
p. Remote-controlled switches, dimmer modules, and control devices.

q. Battery-inverter units.
r. Battery racks.
s. Power-generating units.
t. Monitoring and control equipment.
u. UPS equipment.

3.3 CEILING GRID LABELS

A. Install ceiling grid labels for all equipment located above ceilings such as disconnect switches, controllers and miscellaneous equipment. Color of labels shall match owner's standards.

END OF SECTION

SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT, COORDINATION, ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study. The study shall include short circuit evaluation, device evaluation, device coordination and arc flash evaluation.

B. The Owner shall be furnished short-circuit and protective device coordination studies as prepared by contractor.

C. Contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current issue of NFPA 70E – Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002, the IEEE Guide for Performing Arc-Flash Calculations.

D. The scope of the studies shall include the electrical distribution equipment shown on the plans.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. The studies shall be submitted to the Owner and Engineer for review and approval prior to final completion.

E. A preliminary Arc Flash Hazard Analysis shall be submitted to the Owner’s Representative and Engineer with new electrical equipment submittals. Equipment submittals will not be reviewed without the study specified herein.

F. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of two (2) bound color copies of the complete final report shall be submitted. Electronic PDF copies of the report shall be provided.

Two (2) CDs containing all study files, including all device curves shall be provided (use the SKM “Project-Backup” command).

G. The report shall include the following sections:

1. Executive Summary including introduction, Scope of Work and Results/Recommendations.
2. Short-Circuit Methodology, Analysis Results and Recommendations.
3. Short-Circuit Device Evaluation Table.
4. Protective Device Coordination Methodology Analysis Results and Recommendations.
5. Protective Device Settings Table.
6. Time-Current Coordination Graphs and Recommendations.
7. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
8. Arc Flashing Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
9. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, devices numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

H. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.
4. Setting report.
5. Arc flash calculations and report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. The Registered Professional Electrical Engineer shall be an employee of the approved firm providing the study.

D. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

E. The approved firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.

F. The engineering firm shall have a minimum of ten (10) years of experience in performing power system studies.

G. The study shall include the stamp or seal and signature of the preparing engineer and shall be reviewed and approved by the Engineer of Record.

H. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

I. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Acceptable Computer Software Developers: Subject to compliance with requirements, provide products by SKM Systems Analysis, Inc. only. The study shall be performed using SKM Systems Analysis Power Tools of Windows (PTW 32).

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory", "very desirable", and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

B. Proceed with coordination study only after relevant equipment submittals have been assembled.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In two (2) hard-copy and two (2) CD electronic-copy formats, PDF submittals, showing the following (use SKM “project Backup” command):

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    e. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Ratings, types, and settings of utility company's overcurrent protective devices.
    e. Special overcurrent protective device settings or types stipulated by utility company.
    f. Time-current-characteristic curves of devices indicated to be coordinated.
    g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.
2. Motor-control center and starters.

3. Distribution panelboard.
4. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Utilize approved computer software program. Include studies of system-switching configurations and alternate operations that could result in maximum fault including arcing fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show momentary (1/2 cycle), interrupting (5-cycle), 30-cycle fault-current values for 3-phase, 2-phase and phase-to-ground faults and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

C. Include on each TCC graph, a complete title with descriptive device names.

D. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

E. Identify the device associated with each curve by manufacturer type, function, and if applicable, tap, time delay, and instantaneous settings recommended.

F. Plot the following characteristics on the TCC graphs, where applicable.

1. Electric utility's overcurrent protective device.
2. Low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
3. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
4. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
5. Ground fault protective devices, as applicable.
6. Pertinent motor starting characteristics and motor damage points, where applicable.
7. The largest feeder circuit breaker in each motor control center and applicable panelboard.

G. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

H. Provide the following:

1. A one-line diagram shall be provided which clearly identified individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus.
2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram
5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
6. Contractor shall notify Owner in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

I. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.

J. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

K. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

L. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

M. Completed data sheets for setting of overcurrent protective devices.

N. Main service entrance switch shall be set to coordinate with utility company.

3.5 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

B. Testing: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

   a. Verify that overcurrent protective devices meet parameters used in studies.
   b. Adjust devices to values listed in study results.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures", and Tables 10.7 and 10.8 in NETA ATS.

3.6 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis.

B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, starters, panelboards) where work could be performed on energized parts.

C. The analysis shall be based on the specific devices installed and include (but not be limited to) the following:

1. Service Entrance Equipment:

   a. All overcurrent protective devices installed in service entrance panels.

2. Feeder Circuits:

   a. All three (3) phase feeder circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.

3. Branch Circuits:

   a. All three (3) phase feeder circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
   b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horsepower.

4. Motor Control Centers:

   a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horsepower.

D. Working distances shall be based on IEEE 1685. The calculated arc flash protection boundary shall be determined using those working distances.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuited calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

1. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Alterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault coordination from motors should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 5 cycles.

H. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear, and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment’s main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to complete the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 Section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Provide the following:

1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted and arcing fault current levels, flash protection

boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.

2. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.
3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

3.7 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protective device settings according to the recommended setting table provided by the coordination study.

B. The contractor shall make modifications to equipment as required to accomplish conformances with short circuit and protective device coordination studies.

C. The Arc Flash Hazard Analysis shall be reviewed and updated to reflect any changes and corrections to conductor length within one week of the final electrical walk through for punch list.

3.8 ARC FLASH LABELS

A. Contractor shall provide a 4.0 in. x 4.0 inc. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designated according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems.
2. ANSI Z535.4 – Product Safety Signs and Labels.
3. NFPA 70 (National Electric Coe) – Article 110.16.

C. The label shall include the following information:

1. System Voltage:

    a. Flash protection boundary.
    b. Personal Protection Equipment category.
    c. Arc-Flash Incident energy value (cal/cm^2).
    d. Limited, restricted and prohibited Approach Boundaries.

        1) Study report number and issue date.

D. Labels shall be printed by a thermal transfer type printer, with no field markings.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment: Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.

2. Wall Mounted Equipment: Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.

    a. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work

F. Owner and engineer approved Arc Flash Hazard warning labels shall be furnished and installed prior to project completion.

3.9 ARC FLASH SAFETY TRAINING

A. Provide a minimum of eight (8) hours of safety training for the Owner and their designated employees/contractors. Safety training shall cover all relevant parts of NFPA 70E and shall include demonstration of proper PPE with regard to specified arc flash labels that will be encountered on the Owner's premises.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Indoor occupancy sensors.
3. Lighting contactors.
4. Emergency shunt relays.

B. Related Sections include the following:

1. Division 26 Sections "Central Dimming Controls" for architectural dimming system equipment.
2. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.
3. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.
4. Division 26 Section "Theatrical Lighting" for theatrical lighting controls.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls; a Genlyte Company.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Paragon Electric Co.; Invensys Climate Controls.
8. Square D; Schneider Electric.
9. TORK.
10. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST or DPDT as indicated on drawings.
2. Contact Rating: 20-A ballast load, 120/240-V ac or as indicated on drawings.
3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays or as indicated on drawings.
4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
5. Astronomic Time: All channels.
6. Battery Backup: For schedules and time clock.

C. Electromechanical-Dial Time Switches: Type complying with UL 917.

1. Contact Configuration: SPST or DPDT as indicated on drawings.
2. Contact Rating: 20-A ballast load, 120/240-V ac or as indicated on drawings.
3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
4. Astronomic time dial.
5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
6. Skip-a-day mode.

7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Paragon Electric Co.; Invensys Climate Controls.
6. Square D; Schneider Electric.
7. TORK.
8. Watt Stopper (The).

B. Description: Solid state, with SPST or DPST 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. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 INDOOR PHOTOELECTRIC SWITCHES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen-Bradley/Rockwell Automation.
2. Area Lighting Research, Inc.; Tyco Electronics.
3. Eaton Electrical Inc; Cutler-Hammer Products.
4. Grasslin Controls Corporation; a GE Industrial Systems Company.
5. Intermatic, Inc.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. MicroLite Lighting Control Systems.
8. Paragon Electric Co.; Invensys Climate Controls.
9. Square D; Schneider Electric.
10. TORK.
11. Watt Stopper (The).

B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

C. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.4 INDOOR OCCUPANCY SENSORS

A. Acceptable 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. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. 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.
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.

D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Detector Sensitivity: 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.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.

E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be 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.

2.5 OUTDOOR MOTION SENSORS (PIR)

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Paragon Electric Co.; Invensys Climate Controls.
5. TORK.
6. Watt Stopper (The).

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
    b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

C. 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.

D. Detection Coverage: Up to 35 feet, with a field of view of 90 degrees.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. 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.
2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.6 LIGHTING CONTACTORS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE Industrial Systems; Total Lighting Control.
5. Grasslin Controls Corporation; a GE Industrial Systems Company.
6. Hubbell Lighting.
7. Lithonia Lighting; Acuity Lighting Group, Inc.

8. MicroLite Lighting Control Systems.
9. Square D; Schneider Electric.
10. TORK.
11. 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.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation.

2.7 EMERGENCY SHUNT RELAY

A. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 or 277 V.

2.8 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 "Low-Voltage Electrical Power 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 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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.

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 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 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 "Identification for Electrical Systems."

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.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of final acceptance by Owner, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

B. Cover ventilating openings to keep out dust.

C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet or snow if handles in inclement weather.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 1 for indoor locations; ventilated drip-proof, NEMA 250, Type 3R for outdoor locations and where indicated on drawings.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.

E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Fungus Proofing: Permanent fungicidal treatment for coil and core.

N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

D. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Transformers shall be floor mounted. Transformers 30 KVA and smaller size may be wall or trapeze mounted if indicated specifically on drawings.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.

    a. Minimum Test Voltage: 100 V, dc.
    b. Minimum Insulation Resistance: 500 megohms.
    c. Duration of Each Test: 10 minutes.

d. Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after final acceptance by Owner, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 15

CIRCUIT BREAKER DISTRIBUTION PANELBOARDS

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. Circuit breaker distribution panelboards and associated equipment rated for 600V or less.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of distribution panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each distribution panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Distribution Panelboard Schedules: As indicated on drawings.

E. Operation and Maintenance Data: For distribution panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain distribution panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. 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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare distribution panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of distribution panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of final acceptance by Owner.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of distribution panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each distribution panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    b. Outdoor Locations: NEMA 250, Type 3R.
    c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.
    d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Distribution Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

    a. Panels and Trim: Steel or galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Same finish as panels and trim.
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top or bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity. Uniform capacity the entire length/height of enclosure.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual vertical sections.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Distribution Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL. Short-circuit current rating shall not be less than 65,000 amps.

2.2 DISTRIBUTION PANELBOARDS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 PANELBOARD SUPPRESSORS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Liebert Corporation.
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric.

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, plug-in or wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

a. Fuses rated at 200-kA interrupting capacity.
b. Fabrication using bolted compression lugs for internal wiring.
c. Integral disconnect switch.
d. Redundant suppression circuits.
e. Redundant replaceable modules.
f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
g. LED indicator lights for power and protection status.
h. Audible alarm, with silencing switch, to indicate when protection has failed.
i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
j. Four-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

a. Line to Neutral: 70,000 A.
b. Line to Ground: 70,000 A.
c. Neutral to Ground: 50,000 A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye, three-phase, four-wire circuits shall be as follows:

a. Line to Neutral: 800 V for 480Y/277/400 V for 208Y/120.
b. Line to Ground: 800 V for 480Y/277/400 V for 208Y/120.
c. Neutral to Ground: 800 V for 480Y/277/400 V for 208Y/120.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store distribution panelboards according to NEMA PB 1.1.

B. Examine distribution panelboards before installation. Reject distribution panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive distribution panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install distribution panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install distribution panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
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 panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

F. Mount distribution panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch empty conduits from distribution panelboard into accessible ceiling space or space designated to be ceiling space in the future.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing distribution panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Distribution Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. 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 panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Distribution Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

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. Lighting and appliance branch-circuit panelboards.
2. Load centers.
3. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: As indicated on drawings.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. 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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.

b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of final acceptance by Owner.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.

c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: Steel or galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top or bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual vertical sections.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Panelboards rated 240 Vac or less shall be equipped with bolt on branch circuit breakers, panelboards shall have short circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical. Panelboards rated 480/277 Vac shall be equipped with bolt on branch circuit breakers, panelboards shall have short ratings as shown on the drawings or as hereinbefore scheduled, but not less than 14,000 amperes RMS symmetrical.

G. Size and location of panels shall be as shown on drawings. In general, all panelboards shall be 42 circuits capacity unless noted otherwise.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.3 LOAD CENTERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Load Centers: Comply with UL 67.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.4 ELECTRONIC-GRADE PANELBOARDS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Liebert Corporation.
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

G. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

1. Accessories:

a. Fuses rated at 200-kA interrupting capacity.
b. Fabrication using bolted compression lugs for internal wiring.
c. Integral disconnect switch.
d. Redundant suppression circuits.
e. Redundant replaceable modules.
f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
g. LED indicator lights for power and protection status.
h. Audible alarm, with silencing switch, to indicate when protection has failed.
i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
j. Four-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

a. Line to Neutral: 70,000 A.
b. Line to Ground: 70,000 A.

c. Neutral to Ground: 50,000 A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye, three-phase, four-wire circuits shall be as follows:

   a. Line to Neutral: 800 V for 480Y/277/400 V for 208Y/120.
   b. Line to Ground: 800 V for 480Y/277/400 V for 208Y/120.
   c. Neutral to Ground: 800 V for 480Y/277/400 V for 208Y/120.

6. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:

   a. Line to Neutral: 400 V.
   b. Line to Ground: 400 V.
   c. Neutral to Ground: 400 V.

7. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

   a. Line to Neutral: 400 V, 800 V from high leg.
   b. Line to Ground: 400 V.
   c. Neutral to Ground: 400 V.

8. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:

   a. Line to Line: 2000 V for 480 V/1000 V for 240 V.
   b. Line to Ground: 1500 V for 480 V/800 V for 240 V.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Mount top of trim 74 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. 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 panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included 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 component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Wall-box motion sensors.
5. Isolated-ground receptacles.
6. Hospital-grade receptacles.
7. Snap switches and wall-box dimmers.
8. Solid-state fan speed controls.
9. Wall-switch and exterior occupancy sensors.
10. Communications outlets.
11. Pendant cord-connector devices.
12. Cord and plug sets.
13. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 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.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Service/Power Poles: One for every 10 installed, but no fewer than one.
2. Floor Service Outlet Assemblies: One for every 10 installed, but no fewer than one.
3. TVSS Receptacles: One for every 10 of each type installed, but no fewer than one.
4. Hospital-Grade Receptacles: One for every 20 installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers' Names: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices (Receptacles, Switches):

a. Cooper Wiring Devices.
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Mfg. Company Inc.
d. Pass & Seymour/Legrand; Wiring Devices Div.

2. Wiring Devices for Hazardous (Classified) Locations:

a. Crouse-Hinds/Cooper Industries, Inc.; Arrow hart Wiring Devices.
b. EGS/Appleton Electric Company.
c. Killark Electric Manufacturing Co./Hubbell Incorporated.

3. Occupancy Sensors:

a. Cooper Industries, Inc.
b. Hubbell Incorporated.
c. Leviton Mfg. Company, Inc.
d. Pass & Seymour/Legrand.
e. The Watt Stopper.

4. Poke-Through, Floor Service Outlets and Telephone/Power Poles:

a. Hubbell Incorporated; Wiring Device-Kellems.
b. Pass & Seymour/Legrand; Wiring Devices Div.
c. Square D/Groupe Schneider NA.
d. Thomas & Betts Corporation.
e. Wiremold Company (The).

5. Multioutlet Assemblies:

a. Hubbell Incorporated; Wiring Device-Kellems.
b. Wiremold Company (The).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

B. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.

C. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

D. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

C. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.

2.4 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:

1. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

C. Isolated-Ground, Duplex Convenience Receptacles:

1. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

D. Hospital-Grade, Duplex Convenience Receptacles: Comply with UL 498 Supplement SD.

1. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

E. Isolated-Ground, Hospital-Grade, Duplex Convenience Receptacles:

1. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Comply with UL 498 Supplement SD. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Comply with NEMA FB 11 and UL 1010.

2.6 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.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

1. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. 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.

2.8 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A.

C. Switches shall be heavy-duty, quiet type.

D. Pilot Light Switches, 20 A:

1. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

E. Key-Operated Switches, 120/277 V, 20 A:

1. Description: Single pole, with factory-supplied key in lieu of switch handle.

F. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

G. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.10 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. Illuminated when "OFF."

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.

2.11 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable rotary knob, 5 A.
2. Three-speed adjustable rotary knob, 1.5 A.

2.12 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. 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.

B. Wall-Switch Sensors:

1. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

C. Long-Range Wall-Switch Sensors:

1. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft.

D. Long-Range Wall-Switch Sensors:

1. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

E. Wide-Range Wall-Switch Sensors:

1. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

F. Exterior Occupancy Sensors:

1. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.13 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:

1. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.14 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic or 0.035-inch-thick, satin-finished stainless steel or 0.04-inch-thick steel with chrome-plated finish.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
5. Material for Devices on Emergency Power: Smooth, high-impact thermoplastic, red in color.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.15 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: Round, die-cast aluminum 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 Category 5e jacks for UTP cable.

2.16 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Pedestal type with services indicated or Flush type with two simplex receptacles and space for two RJ-45 jacks.
2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
4. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.
5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, 4-pair, Category 5e voice and data communication cables.

2.17 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

B. Raceway Material: Metal, with manufacturer's standard finish.

C. Wire: No. 12 AWG.

D. Number of Circuits: As indicated on drawings.

2.18 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch-square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
3. Finishes: Manufacturer's standard painted finish and trim combination.
4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
6. Voice and Data Communication Outlets: Four RJ-45 Category 5e jacks.

2.19 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory or White or As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: As specified above, with orange triangle on face].

PART 3 - EXECUTION

3.1 APPLICATION

A. Wiring devices, on emergency power circuits, shall be red in color.

B. Tamper resistant receptacles shall be utilized in all Pediatrics areas, children's play areas, public waiting rooms and public toilet rooms.

C. Stainless steel wall plates shall be utilized for switches and receptacles, on normal power, located in critical areas (Surgery, PACU, Delivery, Nursery, ICU, Cath Lab, etc.) within Healthcare facilities.

D. All wall plates, serving normal power devices, within a room or area shall be same type – either thermoplastic or stainless steel. Mix matching of wall plates shall not be acceptable.

E. All wiring devices, located with Healthcare facilities, shall be hospital grade.

3.2 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. 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 the 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 just 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 and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they 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 using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the 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.
10. Install devices and assemblies level, plumb and square with building lines.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles at top, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
3. Install ground pin of vertically mounted receptacles, located more than 60” above floor, at bottom.

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.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

J. Install GFCI receptacles as shown on drawings and within 60 inches of water source.

3.3 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switch Wall Plates: Identify panelboard and circuit number from which served. Use 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. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. 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 not acceptable.
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. The 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.

C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

END OF SECTION

SECTION 262813

FUSES

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. Cartridge fuses rated 600-V ac and less for use in enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches and panelboards.
3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
4. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.

2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.4 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.

E. Comply with UL 248-11 for plug fuses.

1.5 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.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

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

A. Cartridge Fuses:

1. Service Entrance: Class L, fast acting.
2. Feeders Rated for More than 600 Amps: Class L, fast acting.
3. Feeders Rated Less than 600 Amps: Class J, time
4. Motor Branch Circuits: Class RK1, time delay.
5. Other Branch Circuits: Class RK5, non-time delay.
6. Control Circuits: Class CC, fast acting.

B. Plug Fuses:

1. Motor Branch Circuits: Edison-base type, single-element time delay.
2. Other Branch Circuits: Edison-base type, dual-element time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

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 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible disconnect switches.
2. Nonfusible disconnect switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 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. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. 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.

D. Comply with NFPA 70.

1.6 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.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Architect's written permission.
4. Comply with NFPA 70E.

1.7 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 for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Group of Schneider Electric.

2.2 FUSIBLE DISCONNECT SWITCHES

A. 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.

B. 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 specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.

6. Lugs: Compression type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE DISCONNECT SWITCHES

A. 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.

B. 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.

C. Type HD, Heavy Duty, Double 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. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Lugs: Compression type, suitable for number, size, and conductor material.

2.4 RECEPTACLE SWITCHES

A. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 600-V ac, 60 A and smaller; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

B. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 600-V ac, 60 A and smaller; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

D. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.5 SHUNT TRIP SWITCHES

A. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

B. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Control Circuit: 120-V ac; obtained from a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

D. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight red ON pilot light.
3. Isolated neutral lug; 100 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.

2.6 MOLDED-CASE CIRCUIT BREAKERS

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

C. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

F. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.7 MOLDED-CASE SWITCHES

A. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

B. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.

2.8 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. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

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. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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.

F. Circuit breakers and switches installed in existing switchgear and switchboard shall have interrupting capacity to match interrupting capacity of switchgear, switchboard, panelboard in which they are installed.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. 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.

D. 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. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    c. 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.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. 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.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5. Retrofit kits for fluorescent lighting fixtures.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Central Dimming Controls" for architectural dimming systems.
3. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
4. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
5. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.4 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. Emergency lighting units including battery and charger.
3. Ballast.
4. Energy-efficiency data.
5. Life, output, and energy-efficiency data for lamps.
6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

1. Lamps: Specified units installed.
2. Accessories: Cords and plugs.

E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.5 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

E. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 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.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of final acceptance by Owner. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of final acceptance by Owner.
2. Warranty Period for Electromagnetic Ballasts: Three years from date of final acceptance by Owner.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two year(s) from date of final acceptance by Owner.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Troffers:

    a. Columbia Lighting; Division of Hubbell Lighting.
    b. LSI Midwest Lighting.
    c. Metalux.
    d. H. E. Williams Inc.

3. Strip Fluorescent Fixtures:

    a. Columbia Lighting; Division of Hubbell Lighting.
    b. Lithonia Lighting.
    c. LSI Midwest Lighting.
    d. H. E. Williams Inc.

4. Under Cabinet Fixtures:

    a. ALKCO; Division of JJI Lighting Group Co.
    b. Columbia Lighting.
    c. Lithonia Lighting.
    d. LSI Midwest Lighting.
    e. Nulite Limited.
    f. H. E. Williams Inc.

5. Exit Signs and Emergency Lighting:

    a. Dual-Lite; Division of Hubbell Lighting.

b. Emergi-lite; Division of Thomas and Betts.
c. Failsafe; Division of Cooper Lighting.
d. Hubbell Lighting, Inc.
e. Lithonia Lighting.
f. Prscolite; Division of Hubbell Lighting.
g. Surelite; division of Cooper Lighting.

6. Downlighting (Recessed, Surface, HID):

a. Edison Price Lighting.
b. Halo; Division of Cooper Lighting.
c. Hubbell Lighting, Inc.
d. Infinity Lighting.
e. The Kirlin Company.
f. Kurt Versen Co.
g. Lithonia Lighting.
h. Lightolier; Division of Genlyte Thomas Co.
i. Prescolite; division of Hubbell Lighting.
j. Rambusch Lighting.

C. In order to create a controlled, competitive bidding climate, the Lighting Fixture Schedule, as indicated on the drawings, was developed around the manufacturer listed in the schedule. Equal products from the manufacturers listed will be acceptable. In limited circumstances, for various reasons, certain fixtures were deemed to be proprietary. In these cases, the language, “No substitutions”, is intended to provide the electrical distributors bidding the job with the ability to assembly the most competitive lump sum price for the lighting fixture/lamp package. The electrical distributor, therefore, has the authority to require unit pricing from the manufacturer’s representatives for those products so specified.

D. Light Fixture Schedule as indicated on drawings.

E. Lamps: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. General Electric Company.
2. Philips Electronics.
3. Siemens Corporation.
4. Osram Sylvania.
5. Westinghouse Corporation.

F. Ballasts: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Advance; Division of Philips Electronics.
2. General Electric Company.
3. Lutron Products.
4. Osram Sylvania.
5. Universal.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

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. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. 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.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, 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 different thickness is indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 20 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.85 or higher.
7. Power Factor: 0.95 or higher.

8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, 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.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

D. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

E. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.

F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 10 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.

H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

a. High-Level Operation: 100 percent of rated lamp lumens.
b. Low-Level Operation: 50 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying 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: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, 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, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
11. Ballast Case Temperature: 75 deg C, maximum.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 10 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.

2.5 EMERGENCY FLUORESCENT 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 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp 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. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. 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 flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp in a remote fixture continuously.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: NEMA 250, Type 1 enclosure.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. 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 flashing red LED.

2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 15 percent.
4. Transient Voltage Protection: IEEE C62.41, Category A or better.
5. Lamp Current Crest Factor: 1.5 or less.
6. Power Factor: .90 or higher.
7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
8. Protection: Class P thermal cutout.
9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.

    a. High-Level Operation: 100 percent of rated lamp lumens.
    b. Low-Level Operation: 35 percent of rated lamp lumens.
    c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast

operating modes are free from negative effect on lamp life and color-rendering capability.

11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.

    a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.
    b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

D. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.

    a. Restrike Range: 105- to 130-V ac.
    b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2. Minimum Starting Temperature: Minus 40 deg F.
3. Open-circuit operation shall not reduce average lamp life.

2.7 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. 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 flashing red LED.

3. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.8 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. 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 flashing red LED.

2.9 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 rapid-start low-mercury lamps, rated 25 W maximum, nominal length of 36 inches 2,000 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

E. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours, unless otherwise indicated.

F. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

G. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

H. Headwall System: Provide lamps for patient light fixtures provided by the headwall manufacturer. The lamps shall be T8, rapid start, 32W for 4 ft. lamps and 25W for 3 ft. lamps. Coordinate type and quantity with headwall system manufacturer.

2.10 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.

1. Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.

B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.12 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES

A. Comply with UL 1598 listing requirements.

1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.
2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

2.13 DIMMING CONTROL DEVICES

A. Dimming Controls: Sliding-handle type with on/off control; compatible with ballast and having light output and energy input over the full dimming range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Headwall System: Install lamps and ballasts for fixtures provided in the pre-manufactured headwall systems. Coordinate type of lamps and quantity with Headwall System manufacturer.

C. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires 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 two independent support rods or wires 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.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 27 05 00

BASIC TELECOMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes:

1. Summary of Work.
2. Regulations and Code Compliance.
3. Intent of Drawings.

1.3 DEFINITIONS / ACRONYMS

AHJ: Authority Having Jurisdiction

ATR: All Thread Rod

BICSI: Building Industries Consulting Services International

DNR: Distributive Network Room

EMI: Electromagnetic Interference

ER: Equipment Room

Furnish: Contractor supplies material only; installation of said material is by others.

Provide: Contractor furnishes and installs material.

IDC: Insulation Displacement Connector

LAN: Local Area Network

NEC: National Electric Code

NRTL: Nationally Recognized Testing Laboratory

ns: Nano-second

PVC: Polyvinyl Chloride

TBB: Telecom Bonding Backbone

TGB: Telecommunications Grounding Busbar

TMGB: Telecommunications Main Grounding Busbar

TO: Telecommunications Outlet

UL: Underwriters Laboratories

UTP: Unshielded Twisted Pair

1.4 SUMMARY OF WORK

A. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the Contract Documents.

B. The Telecommunications Contract includes but is not limited to the following:

1. Backbone Fiber Optic Cabling System and associated hardware.
2. Backbone Analog Voice Cabling System and associated hardware.
3. Distributive Network Room (DNR) Equipment and associated hardware.
4. Horizontal Category 6A, Category 6 and Category 5e Cabling System and associated hardware.
5. Station outlets, faceplates and terminations.
6. Testing and Certification.
7. Identification and Administration.
8. Grounding and Bonding.
9. As-Built Drawings, Operations and Maintenance Manuals, Project Close Out Administration.
10. Cutover and Training.
11. Support and Warranty.

1.5 REGULATIONS AND CODE COMPLIANCE

A. The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below are incorporated by reference:

1. This Technical Specification and Associated Drawings.
2. National Fire Protection Agency (NFPA) - 70, National Electrical Code (NEC) – 2008.
3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises – 2009.
4. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard – 2009.
5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunication Cabling and Components Standard – 2009.
6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard – 2008.
7. ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces – 2004.
8. TIA/EIA-604-10A FOCIS 10 Fiber Optic Connector Intermateability Standard – Type LC.

9. ANSI/TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings – 2002.
10. ANSI-J-STD-607(A) Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications – 2002.
11. TIA-455-21-A FOTP-21 – Mating Durability of Fiber Optic Interconnecting Devices – 1998.
12. ANSI/TIA-455-61 FOTP-61 – Measurement of Fiber or Cable Attenuation Using an OTDR.
13. TIA-526-7-OFSTP-7 – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – 2002.
14. TIA-526-14A-OFSTP-14 – Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – 2003.
15. ANSI/TIA-758-A – Customer Owned Outside Plant Telecommunications Cabling Standard.
16. Building Industries Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM) – 12th Edition.
17. BICSI Information Transport Systems Installation Manual – 5th Edition.
18. BICSI Outside Plant Design Reference Manual – 4th Edition.
19. ANSI/NECA/BICSI-568-2006 – Standard for Installing Commercial Building Telecommunications Cabling – Latest Edition.
20. BICSI Network Design Reference Manual – 6th Edition.

B. If a conflict exists between applicable documents, then the order in the list above shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity, and is therefore enforceable as law by a local, state, or federal inspection agency.

C. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents, The Contractor is responsible to determine and adhere to the most recent release when completing the installation.

1.6 INTENT OF DRAWINGS

A. Drawings are diagrammatic to indicate general character and intent of work included. The Contractor shall complete a site visit to confirm all dimensions and work shown on drawings prior to bidding the project. Failure of the Contractor to complete the site visit shall not relieve the Contractor of all requirements indicated in the Contract Documents. The Architect reserves the right to make reasonable changes in outlet locations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 27 05 50
FIRESTOPPING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Firestopping of through penetrations in fire rated assemblies.

B. Smoke seals.

C. Construction enclosing compartmentalized areas.

1.2 RELATED SECTIONS

A. Division 3 – Section 033000 – Cast-In-Place Concrete.

B. Division 4 – Section 042200 – Concrete Unit Masonry.

C. Division 9 – Section 092000 – Plaster and Gypsum Board.

D. Division 7 – Section 078413 – Penetration Firestopping.

E. Division 26 – Section 260000 – Electrical.

F. Division 27 – Section 270000 – Communications.

1.3 REFERENCES

A. ASTM E 84, “Surface Burning Characteristics of Building Materials”.

B. ASTM E 119, “Fire Tests of Building Construction and Materials”.

C. ASTM E814, “Fire Tests of Penetration Firestop Systems”.

D. ANSI/UL263, “Fire Tests of Building Construction and Materials”.

E. ANSI/UL723, “Surface Burning Characteristics of Building Materials”.

F. ANSI/UL1479, “Fire Tests of Through Penetration Firestops”.

G. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory.

H. National Fire Protection Association (NFPA) – NFPA 101: Life Safety Code.

I. National Fire Protection Association (NFPA) – NFPA 70: National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

A. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur, such devices shall:

1. Meet the hourly rating of the floor or wall penetrated.
2. Permit the allowable cable load to range from 0% to 100% visual fill thereby eliminating the need to calculate allowable fill ratios.
3. Not require any additional action on the part of the installer to open or close the pathway device or activate the internal smoke and fire seal, such as, but not limited to:

    a. Opening or closing of doors.
    b. Twisting an inner liner.
    c. Removal or replacement of any material such as, but not limited to, sealant, caulk, putty, pillows, bags, foam plugs, foam blocks, or any other material.

4. Permit multiple devices to be ganged together to increase overall cable capacity.
5. Allow for retrofit to install around existing cables.
6. Include an optional means to lengthen the device to facilitate installation in thicker barriers without degrading fire or smoke sealing properties or inhibiting ability of device to permit cable moves, add-ons, or changes.

B. Where single cables (up to 0.27 in. (7 mm) diameter) penetrate gypsum board/stud wall assemblies, a fire-rated cable grommet may be substituted. Acceptable products shall be molded from plenum-grade polymer and conform to the outer diameter of the cable forming a tight seal for fire and smoke. Additionally, acceptable products shall lock into the barrier to secure cable penetration.

C. Where non-mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, seating pipes, ponding water or other forms of moisture characteristic during or after construction.

D. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.

E. Cable trays shall terminate at each barrier and resume on the opposite side such that cables pass independently through fire-rated pathway devices. Cable tray shall be rigidly supported independent from fire-rated pathway devices on each side of barrier.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Provide manufacturer’s standard catalog data for specified products demonstrating compliance with references standards and listing numbers of systems in which each product is to be used.

C. Shop Drawings: Submit schedule of opening locations and sixes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.

D. Certificates: Products certificates signed by firestop manufacturer certifying material compliance with applicable code and specified performance characteristics.

E. Installation Instructions: Submit manufacturer's printed installation instructions.

1.6 QUALITY ASSURANCE

A. Products/Systems: Provide firestopping systems that comply with the following requirements:

1. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
2. Firestopping products bear the classification marking of qualified testing and inspection agency.

B. Installer Qualifications: Experience in performing work of this section who is FM4991 qualified and qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multi-component products.
2. Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

B. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 PROJECT CONDITIONS

A. Do not install firestopping products when ambient or substrate temperatures are outside of limitations recommended by manufacturer.

B. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.

C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.

D. Do not use materials that contain flammable solvents.

E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

G. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Specified Technologies Inc., 200 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: specseal@stifirestop.com, Website: www.stifirestop.com.

B. Substitutions: Not permitted.

C. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.2 MATERIALS

A. General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

B. Firestop Sealants: STI SpecSeal® Brand single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant.
2. Specified Technologies Inc. (STI) SpecSeal® Series LCI Sealant.

C. Firestop Putty: STI SpecSeal® Brand intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty.

D. Firestop Pillows: STI SpecSeal® Brand re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows.

E. Fire Rated Cable Pathway: STI EZ-PATH™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:

1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway.

F. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves, the following products are acceptable:

1. Specified Technologies, Inc. (STI) SpecSeal Series FP Firestop Plug.

G. Fie-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual cable penetrations up to 0.27 in. (7 mm) diameter, the following products are acceptable:

1. Specified Technologies Inc. (STI) Ready Firestop Grommet

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.

B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.

C. Provide masking and temporary covering to protect adjacent surfaces.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classifications as specified in the published design.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

3.3 Field Quality Control

A. Inspections: Owner shall engage qualified independent inspection agency to inspect through-penetration firestop systems.

B. Keep areas of work accessible until inspection by authorities having jurisdiction.

C. Where deficiencies are found, repair firestoppping products so they comply with requirements.

3.4 Adjusting And Cleaning

A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

3.5 SCHEDULES

	Concrete Floor	Concrete Wall	Gypsum Board Wall
Penetrant Type			
Blank Opening	C-AJ-0100, C-AJ-0101	C-AJ-0100, C-AJ-101	
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100	W-L-1049, W-L-1222, W-L-1168
Plastic Con-duits/ Raceways	C-AJ-2140, C-AJ-2292	W-J-2018, W-J-2076	W-L-2093, W-L-2241
Cables	F-A-3021, F-A-3037	W-J-3098, W-J-3130, W-J-3158, W-J-3180	W-L-3218, W-L-3255, W-L-3306, W-L-3377
Cable Trays	C-AJ-4029	W-J-4021, W-J-4022, W-J-4033	W-L-4008, W-L-4029, W-L-4043

END OF SECTION

SECTION 270600

ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes:

1. Project Meetings.
2. Coordination with Owner.
3. Submittals.
4. Record / As-Built Drawings.

1.3 PROJECT MEETINGS

A. This Contractor shall attend weekly job meetings during the entire course of the project as directed by the Architect.

B. The purpose of the meetings shall be to coordinate the work of this contract with all other contractors on the project and to address any conflicts or problems that may arise during the course of construction.

C. Scheduling, delivery and storage of materials and labor resources shall be coordinated weekly.

1.4 COORDINATION WITH OWNER

A. This Contractor shall closely coordinate all work with the Architect, Owner and all other contractors.

B. No system shutdown or cutover shall be completed prior to providing the Owner and Architect with 72 hour advance notice.

C. It will not be permitted to complete any cabling, voice system or data LAN electronics system cutover or shutdown during Monday through Friday. All systems cutover and shutdowns shall be completed on a Friday after 5:00 PM and must be fully functional prior to the following Monday morning at 5:00 AM. If it becomes apparent (at least 10 hours before Monday at 5:00 AM) the cutover will not be successful, the Contractor will be required to reinstall and assemble all the old cabling systems, to their original state, and have all existing systems functional prior

to Monday at 5:00 AM. The Contractor will then be required to provide 72 hours notice to the Owner and Architect before attempting the cutover again.

1.5 SUBMITTALS

A. This Contractor shall submit the following documents to the Architect for approval prior to placing any orders for materials and equipment or completing any work on-site with the number of copies as directed by the Architect:

1. A Submittal Log prepared and submitted by the Contractor showing each item and product, which will be submitted for the project.
2. Coordination drawings showing exact dimensions of all racks, cabinets, enclosures, other equipment and telecommunications closets shall be drawn on a scale of 1/4" = 1'0". Floor plans shall be drawn on a scale of 1/8" = 1'-0". The coordination drawings shall show all cable and outlet identifiers for each network drop throughout the building. These drawings shall be reviewed with other contractors and the Architect to verify no installation conflicts exist. (The existing telecommunications drawings will be provided, in electronic format, to the successful Contractor to assist in preparation of the coordination drawings.)
3. Manufacturer specification data sheets and / or shop drawings shall be submitted on every product, part and equipment used on this project.

B. Two (2) copies of Operation and Maintenance Manuals shall be submitted within 30 days of project substantial completion. The O&M Manuals shall include but not limited to the following:

1. Mfg. Manuals of all equipment.
2. Mfg. Installation instructions.
3. Mfg. Operations Manuals.
4. Mfg. Maintenance Manuals.
5. An approved copy of all submitted shop drawings and manufacturer specifications sheets.
6. All Mfg. Warranty documents for every product.
7. All multimode and singlemode fiber optic power meter test results.
8. OTDR Traces of all SM fiber optic cable.
9. Level III Category 6A and Category 6 Test results of all network drops.
10. Level III Category 5e Test results of all analog voice drops.
11. The 25-year Performance Warranty certificate from the Mfg. of the network cabling system.
12. Manuals shall be in multiple volumes in three ring binders not thicker than three inches.
13. Manuals shall be tabbed for each major section and network closet for test results.
14. A CD-ROM containing the following:

    a. Categories 6A, 6 and 5e; fiber optic power meter and fiber optic OTDR trace test results.
    b. The test equipment utility software to read all tests.
    c. A copy of the 25-year Performance Warranty and any Warranty registration documents required to register the project with the mfg.
    d. The final set of As-Built (AutoCAD, VISIO or equal) Drawings.
    e. Any other documentation that is readily available to allow the Owner to manage their network in the future.

1.6 RECORD / AS-BUILT DRAWINGS

A. During the course of the project the Contractor shall maintain a full set of Telecommunications drawings on-site for the sole purpose of red lining any changes and or modifications in the work. This set of drawings shall be updated on a daily basis. The following shall be shown and or revised on the As-Built drawings:

1. Any outlet locations that have moved more than 12 inches.
2. Exact location of all equipment racks, cabinets and enclosures.
3. Primary cable pathways.
4. Location of grounding bus bars and grounding terminations.
5. Exact layout of every equipment rack elevation showing all cable management, patch panels, fiber optic enclosures, patch panel labeling and identification, network electronics, etc.
6. Every outlet identifier matching the test result identifier.
7. Exact telecommunications backboard layouts and elevations.
8. Any revisions to outlet details.

B. At project completion, the Contractor shall revise all items noted above on the electronic drawings and submit two (2) copies in paper and electronic version to the Architect for approval.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 27 07 00

QUALITY ASSURANCE REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes:

1. Quality Control.

1.3 QUALITY CONTROL

A. The Telecommunications Contractor shall be experienced in installations of this type and shall have at least 5 years documented experience.

B. The following shall be submitted WITH THE BID to allow the Owner and Architect to verify the Telecommunications Contractor is qualified to complete this project. Failure to submit the following items with the bid shall be cause for disqualification of the bidder:

1. A current BICSI Registered Communications Distributions Designer (RCDD) Certificate. This RCDD shall be on staff and shall ultimately be responsible for the overall project.
2. A current Certificate from the manufacturer of the Network Cabling / Hardware Infrastructure verifying the Telecommunications Contractor is certified to execute and issue the 25-year Performance Warranty required on this project.
3. Certificates demonstrating manufacturer certification of the Contractor’s installers who will be working on this project.

C. The following shall be submitted as required to allow the Owner and Architect to evaluate the Telecommunications Contractor’s performance in past projects:

1. A documented list of references from five projects completed during the past 5 years that were similar in size and nature, listing the following:

a. Owner name, address and phone number.
b. Contact name.
c. Project name.
d. Brief description of project.
e. Contract value.
f. Contract completion date.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 27 08 00

TESTING, IDENTIFICATION AND ADMINISTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes:

1. Testing Categories 6A, 6 and 5e Cabling.
2. Testing Fiber Optic Cabling.
    a. Power Meter.
    b. Optical Time Domain Reflectometer (OTDR).
3. Labeling / Documentation.
4. Test Results / As-Built Drawings.

1.3 REFERENCE STANDARDS

A. All regulations and references shall be as specified in section 27 05 00.

1.4 SUBMITTALS

A. All submittals shall be as specified in section 27 06 00.

B. A copy of the RCDD certification from BICSI Institute as specified in Section 27 07 00 shall be submitted for approval.

C. Samples of each type of test result for copper; Single-mode (SM) fiber optic power meter and SM fiber optic OTDR traces shall be submitted for approval.

D. Samples of each type of proposed label (to include faceplate, patch panel and cable marking labels) shall be submitted for approval.

1.5 QUALITY ASSURANCE

A. Install all products in accordance with the manufacturer’s instructions.

B. The manufacturer of the cabling system being installed shall have trained the Contractor’s installers; said installers shall have at least 2 years experience in the installation of Infrastructure Cabling Systems. Technicians completing the testing and certification of the cabling shall be experienced in all functions of the test equipment.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. The specified test equipment shall be independently verified by ETL to meet ISO Level IV and TIA Level IIIe Accuracy requirements, and shall be capable to test the following parameters:

1. Wiremap:

a. The wiremap measurements shall check for proper end-to-end continuity and pairing. Problems to be detected are:

1) Short Circuit
2) Open Circuit
3) Reversed Pairs
4) Transposed Pairs
5) Split Pairs
6) Shield Continuity Faults

b. Length:

1) The length measurements shall determine the electrical length of the Basic Link cabling run under test. Length measurements shall require the accurate cable nominal velocity of the propagation (NVP) setting to yield specified accuracy. NVP values shall automatically load when the correct cable is selected from the test instruments built-in database. The test equipment shall be capable of the following:

a) Accuracy: +/- (2ns + 2%)
b) Resolution: 1 foot

c. Propagation Delay:

1) The propagation delay functions shall measure the one-way propagation delay over each pair of the cabling run under test. The test equipment shall be capable of the following:

a) Accuracy: +/- (2ns + 2%)
b) Resolution: 1 ns
c) Range: 750 ns

d. Delay Skew:

1) Delay Skew shall be calculated as the difference in ns between the longest and shortest measured propagation delay among the four pairs of a single cabling run.

a) Accuracy: +/- 10 ns
b) Resolution: 1 ns
c) Range: 0 to 100 ns

e. Near End Crosstalk (NEXT):

1) Measures near end coupling between pairs in the cabling run under test. Shall be measured at both ends of the cabling over 6 pair combinations.

f. Insertion Loss (Attenuation):

1) The test equipment shall test the attenuation of all four pairs.

g. Return Loss:

1) The test equipment shall measure the return loss of all four pairs from each end of the cabling run under test.

h. Equal Level Far End Cross Talk (ELFEXT):

1) The test equipment shall measure far end coupling between pairs in the cabling run under test and for all pair combinations.

i. Attenuation to Crosstalk Ratio (ACR):

1) The test equipment shall compute this test by subtracting the measured attenuation from the near end crosstalk (NEXT) at each frequency point.

j. Power Sum NEXT (PSNEXT):

1) The test equipment shall compute this test for each pair by calculating a power sum total of the pair-to-pair NEXT from the three other pairs.

k. Power Sum ELFEXT (PSELFEXT):

1) The test equipment shall compute this test for each pair by calculating a power sum total of the pair-to-pair ELFEXT from the three other pairs.

l. Power Sum ACR (PSACR):

1) The test equipment shall compute this test by subtracting the measured attenuation from the computed power sum near end crosstalk (PSNEXT) at each frequency point.

m. Resistance:

1) The test equipment shall measure the DC loop resistance for each pair in the tested cabling run.

n. The specified test equipment shall test the Category 6A, 6 and 5e cabling to the following:

1) Category 6A, 6 or 5e Permanent Link as applicable per cable type, per EIA/TIA 568-C.
2) List the Site information (End User).
3) List the manufacturer of the cabling system and type: (Category 6A, 6 or 5e CMP).
4) List the manufacturer of the jacks and type (Category 6A, 6 or 5e).
5) List the cable pairing: (T568B).

6) List the measurements (EIA/TIA 568-C).

a) Wiremap.
b) NEXT.
c) Return Loss.
d) PS NEXT.
e) Delay.
f) Length.
g) Attenuation.
h) ELFEXT.
i) PS ELFEXT.
j) Delay Skew.

7) Shall be tested in the Certification Mode.
8) Summary ELFEXT Mode.
9) Shall calculate fault location.
10) Maximum Frequency for Category 6A: 500 MHz.
11) Maximum Frequency for Category 6: 250 MHz.
12) Maximum Frequency for Category 5e: 100 MHz.
13) List all test results with numerical data AND plots.
14) List whom the operators are completing the testing.

o. The test equipment used for the copper cabling shall be as manufactured by Fluke Series Versiv or approved equal.

2.2 TEST EQUIPMENT (FIBER OPTIC)

A. Power Meter and Light Source shall test to the following parameters:

1. The specified test equipment shall be able to test Single-mode fiber optic cable at 1310 and 1550 nm in both directions, and generate one test result from this dual ended test.
2. The test shall be completed with the Length / Loss Method where the operator can set the following:

a. Quantity of connectors.
b. Loss per connector (0.75 dB).
c. Quantity of splices.
d. Loss per splice (0.30).
e. Cable loss (1300nm 1.0 dB/Km).

3. Length Limit (Horizontal 90M, Backbone 2 Km).
4. Show the type of glass being tested.
5. List the Site information (End User).
6. List whom the operators are completing the testing.
7. The test equipment used for the fiber optic single-mode cabling shall be as manufactured by Fluke, Series Versiv with Single-mode Fiber Modules to allow for dual ended testing at both wavelength windows, or approved equal.

B. Optical Time Domain Reflectometer (OTDR):

1. OTDR testing shall be completed on all Single mode fiber optic backbone cabling. Traces shall show the following:

a. Exact traces of the fiber cable being tested including every splice, connector and / or other type of signal loss.
b. Shall be completed with test equipment listing the latest parameters required by the TIA/EIA 568-C standards.
c. Shall list the exact length of each single mode fiber optic strand.

2. All OTDR traces shall be completed with an OTDR as manufactured by Laser Precision part number TD2000 OTDR Mainframe, Tektronix part number TFP2 FiberMaster OTDR Mainframe or equal.

2.3 LABELING / DOCUMENTATION

A. Faceplates, Patch Panels, Equipment Racks:

1. Faceplates and patch panels shall be identified using durable machine-generated labels.
2. The labels shall be 3/8" wide, white background and black letters.

a. Letters shall be at least ¼" high for faceplates and patch panels. Letters shall be at least 3/8" high on ½" labels for equipment racks.
b. The labels shall be laminated with a clear plastic lamination over the top of the label and letters for protection.
c. Labels shall be as manufactured by Brother Industries, LTD part number TZ221 and TZ231 or approved equal.
d. The printer used for the labels shall be as manufactured by Brother Industries, LTD part number P-Touch PT-340 or approved equal.

B. Cable Markers for Copper and Fiber Optic Cables:

1. All cables shall be identified at BOTH ends (faceplate and patch panel) using durable machine generated labels.
2. The labels shall be 1" wide, ½" of white printable area and ¾" of clear adhesive to wrap around the cable and cover the machine printed text.
3. Letters shall be at least 1/8" high.
4. Cable marker labels shall be as manufactured by Brady Worldwide, Inc. part number WML-311-292 or approved equal.
5. The printer used for the labels shall be as manufactured by Brady Worldwide, Inc. part number I.D. PRO PLUS or approved equal.

C. Color Coding:

1. The color codes for cross-connect fields are shown in the following table.

a.	Orange	Demarcation point (e.g., central office terminations).
b.	Green	Network connections (e.g., network and auxiliary equipment).
c.	Purple	Common equipment, PBX, LANS, BAS.
d.	White	Horizontal voice cabling.
e.	Blue	Horizontal data cabling.
f.	Brown	Interbuilding backbone.
g.	Yellow	Miscellaneous (e.g., auxiliary, alarms, security).
h.	Red	Fire Alarm

2.4 TEST RESULTS, AS-BUILT DRAWINGS

A. Network Cabling Test Results:

1. Three ring binders shall be of high quality and no more than 3” thick.
2. Multiple volumes shall be used as required.
3. Tabs used in the binders shall be of good quality and have laser printed labels on the tabs.
4. CD-ROMs used for the soft copy for test results shall be of the record / write type.

B. As-Built Drawings:

1. As-built drawings shall be printed on durable paper to ensure long lasting documents for the Owner’s use.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate and sequence all work in accordance with the schedule established by the Owner, Architect and the lead Prime Contractor.

3.2 INSTALLATION

A. Testing Copper Cabling:

1. All test instruments shall have been calibrated by the manufacturer of the test equipment within the past year. This manufacturer calibration sheet shall be forwarded to the Architect or Owner upon request.
2. Daily equipment calibration shall be performed by the operator in the field prior to completing any test on any given day.
3. All cable identifiers entered into the test equipment shall match the identifiers on the faceplates, patch panels and As-Built drawings.
4. Copper cabling shall be tested as noted in Part 2 above. Every run of Category 6A, Category 6 and Category 5e cabling shall be tested, corrected and re-tested if required, ensuring 100% of all drops have passed all the testing requirements noted.

B. Testing Fiber Optic Cabling:

1. All test instruments shall have been calibrated by the manufacturer of the test equipment within the past year. This calibration sheet shall be forwarded to the Architect or Owner upon request.
2. Daily equipment calibration shall be performed by the operator in the field prior to completing any test on any given day.
3. All cable identifiers entered into the test equipment shall match the identifiers on the faceplates, patch panels and As-Built drawings.
4. Fiber optic cabling shall be tested as noted in Part 2 above. Every strand of cabling shall be tested, corrected and re-tested if required; ensuring 100% of all strands have passed all the testing requirements noted.
5. Optical fiber attenuation shall be measured in both directions at both 1310 nanometers (NM) and 1550 NM a light source and power meter. Test set-up and performance shall be conducted in accordance with ANSI/EIA/TIA-526-7 Standard, Method B. One 2-meter patch cord shall be used for the test reference and two 2-meter patch cords shall be used for the actual test. This test method uses a one-jumper reference, two-jumper test to estimate the actual link loss of the installed cables plus the loss of two connectors. This measurement is consistent with the loss which network equipment will see under normal

installation and use. Test evaluation for the panel to panel (backbone) or panel to outlet (horizontal) shall be based on the values set forth in ANSI/TIA-568-C.

C. Labeling / Documentation:

1. Each faceplate shall be identified with the products specified in Part 2.
2. Each patch panel shall be identified with the patch panel value, i.e. A, B, C, etc.
3. Each equipment rack shall be identified with the Closet value, i.e. NW2, etc.
4. Each horizontal and backbone cable shall be identified with the cable marker labels specified in Part 2.
5. Labeling Nomenclature:

a. An existing identification method is in use by the Owner on campus. The following labeling nomenclature shall be followed for this project (see diagram on next two pages):

1) WC = Wiring Closet
2) NWPT = Building Identification, i.e.: Northwest Patient Tower
3) NW2 = Wiring Closet Identification
4) A = Patch panel
5) 03 = Port Number
6) Example = (WCNWPT – NW2 – B03)
7) Faceplate labeling will be as follows:

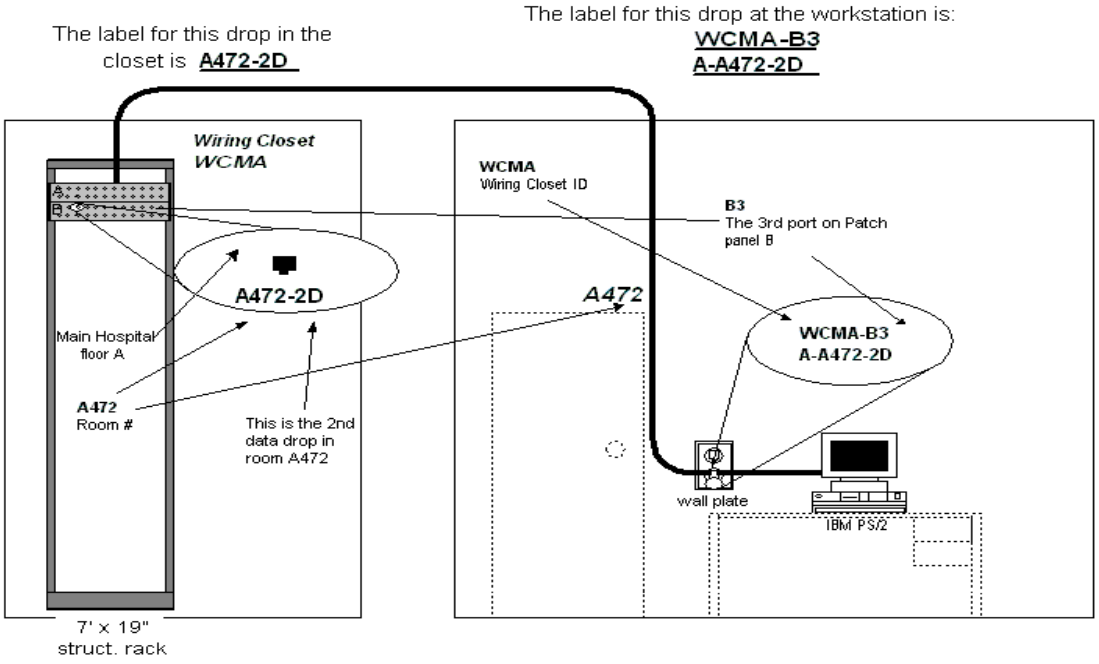
a) NWPT2 = Building Identification and floor number
b) 2415 = Unique room number
c) 1 = Sequential jack number within unique room
d) D = Data

SLHS Data Cable Labeling standard

11-25-03

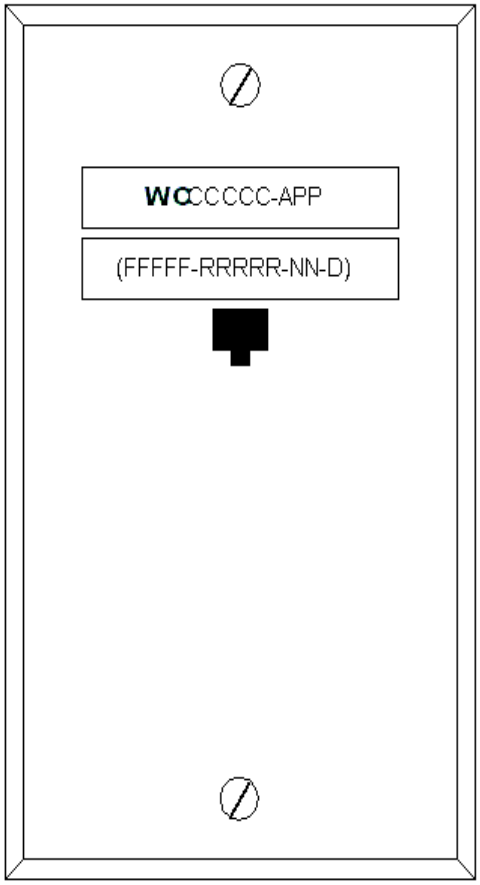
Workstation
The workstation label will be based on the location of the destination in the wiring closet. The label structure is detailed out in Appendix A(workstation).

Wiring Closet
The wiring closet label will be based on the location of the destination room. If this is new construction the whole panel will be labeled with a unique letter centered on the left center and facility floor ID placed at the top center in bold. If this is an existing patch panel the facility floor ID will be placed above the port. The structure of the label is detailed out in Appendix A(Patch Pane in closet).



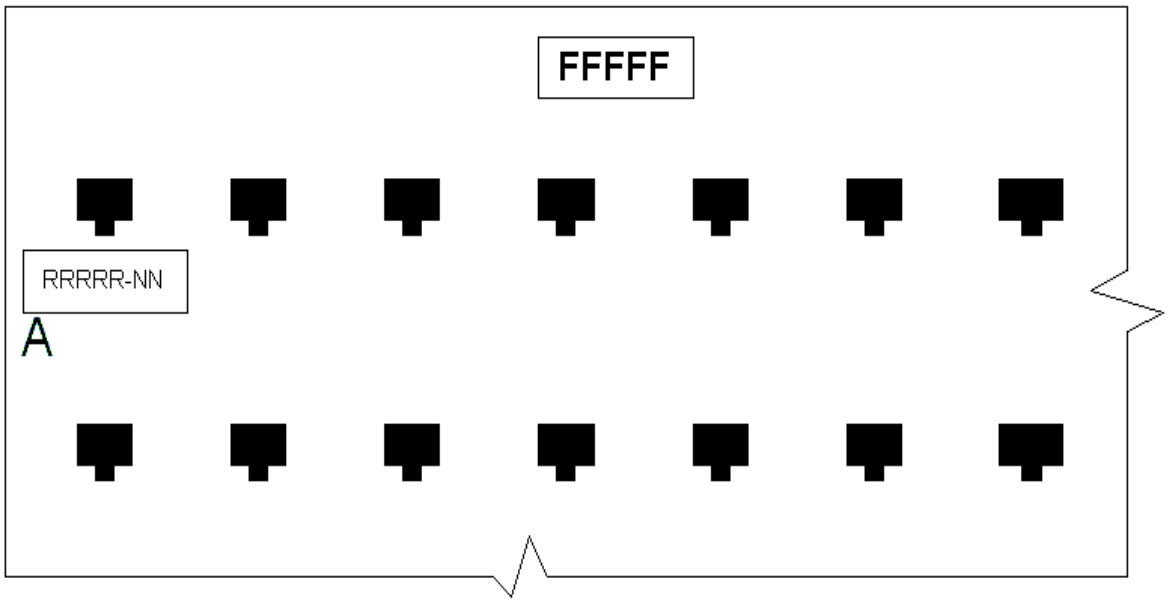
Wiring Closet Label Standard For Saint Lukes Health System (Appendix A)

Workstation



B = Building ID
C = Wiring Closet ID
A = Patch Panel Letter
P = Patch Panel Port Number
F = Facility Floor
R = Room Number
N = Unique sequential number(in room)
D = Data

Patch Panel in closet



8) All backbone cabling shall be labeled as follows:

a) MC IC FO1-12 (From Closet MC to Closet IC, Fiber Optic cable, strand 1 thru 12.)
b) IC TC1 V1-50 (From Closet IC to Closet TC1, Voice Cable, Pairs 1 thru 50).

D. Test Results / As-Built Drawings:

1. Test results shall be printed, sorted and assembled into three ring binders.
2. Test results shall show all values as specified including plot style graphs for each cable. Test results with numerical values only will not be acceptable.
3. Test results shall be assembled in sequential order starting with closet MC, IC and TC-1, etc.
4. Closets shall be separated by durable tabs with machine-generated labels.
5. All backbone test results shall be separated from the horizontal test results with tabs.
6. Manuals shall be assembled in accordance with Section 27 06 00.
7. As-Built information shall be collected and updated manually on drawings stored in the field expressly for recording changes. These drawings shall be revised at least once a week during the course of the project to accurately depict all field revisions.
8. As-Built drawings shall then be updated in electronic format and printed showing all changes and revisions throughout the project.
9. All as-built records shall be in accordance with Section 27 06 00.
10. Archive CD-ROMs shall be created in accordance with Section 27 06 00.

END OF SECTION

SECTION 27 11 00

DISTRIBUTIVE NETWORK ROOMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Entire Divisions 26 and 27.

C. Note, the terms Distributive Network Rooms (DNRs), IT Rooms, Telecommunications Closets, and IDFs are used interchangeably throughout the construction documents.

1.2 SUMMARY

A. This Section includes:

1. Requirements of DNR spaces, including but not limited to room dimensions, flooring, power, and cooling.
2. Labor, equipment, materials and tools required to fit out the DNRs to allow them to support all associated Work Areas and connect them to Intermediate Cross Connects or the Main Cross Connect.
3. Equipment Racks and Cabinets.
4. Cable Management.
5. Patch Panels.
6. Optical Patch Panels and Hardware including Fusion-Splice Cassettes.
7. Termination Blocks.
8. Ladder Runway.
9. Copper Patch Cords, Cable Assemblies.
10. Fiber Optic Patch Cords, Cable Assemblies.

B. Refer to project drawings for additional information on DNR components required, and sizing / quantities thereof.

1.3 SUBMITTALS

A. Manufacturers’ catalog sheets, specifications and installation instructions for all products to be installed within the scope of work included under this contract.

B. A copy of the BICSI RCDD certificate as specified in Section 270700 shall be submitted for approval.

1.4 QUALITY ASSURANCE

A. All equipment and materials shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the

acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Install all products in accordance with the manufacturer's instructions.

C. The manufacturer of the cabling system being installed shall have trained the Contractor's installers; said installers shall have at least 2 years experience in the installation of Infrastructure Cabling Systems.

D. Manufacturer: The network cabling equipment shall be manufactured by a firm engaged in the manufacture of network cabling systems for a period of at least 10 years.

E. All network cabling equipment must be manufactured by a single manufacturer for the entire cabling system.

F. The materials and work listed in this Section shall comply with the applicable requirements of industry standards and documents per Section 270500.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers are shown with each product type below. CommScope Products required as indicated to qualify for required 25-year Manufacturer's Warranty. Prior approval required for any alternates.

2.2 EQUIPMENT CABINETS

A. Equipment Cabinets shall be provided in ERs and DNRs as shown on drawings, and unless otherwise indicated shall be APC Netshelter Type SX-42U as distributed by Electronic Supply Company.

1. Cabinet for Network Switch / Patch, and adjacent cabinet for Network Switch and Patch overflow, shall each be APC # AR3150.
    a. Reserve and leave blank, the center-most 14 rack units of space in the Network Switch / Patch equipment cabinet, for Owner to furnish and install the network switch equipment.
    b. Remove side panels from AR3150 cabinets prior to installation, and deliver side panels to Owner for possible future use.

2. Cabinet for Telemetry, Patient Monitoring, Bio-Medical, and Security shall be APC # AR3100.

B. Power Distribution Units (PDUs) shall be provided in quantity of (2) per cabinet, and Automatic Transfer Switch (ATS) shall be provided in quantity of (1) per cabinet:

1. In Network Switch / Patch cabinet, and in Network Switch and Patch Overflow cabinet:

    a. Each PDU shall be 208 Volt, APC # AP8941.
    b. Each ATS shall be 208 Volt, APC # AP4434.

2. In Telemetry / Patient Monitoring / Bio-Medical / Security cabinet:

a. Each PDU shall be 120 Volt, APC # AP8930.
b. Each ATS shall be 120 Volt, APC # AP4450.

2.3 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Provide UPS rack-mounted in bottom-portion of Telemetry / Patient Monitoring / Bio-Medical / Security equipment cabinet unless otherwise noted. UPS shall be sized based on initial connected equipment power load plus 50% spare capacity.

B. Where connected equipment load plus 50% is less than or equal to 5 kVA, provide APC UPS # SUA5000R5TXFMR.

C. Where connected equipment load plus 50% is greater than 5 kVA, provide APC UPS # SYA8K16RMP with 8 kVA capacity, expandable to 16 kVA in future. Furnish with the following quantities of output receptacles: (4) L5-20; (2) L14-30; (2) L6-30; and (4) L6-20, unless otherwise noted on drawings. In order to achieve the above output receptacles, furnish and install (2) backplate kits SYPD3. Deliver the (2) standard power panels SYPD1 that are removed to make space for the SYPD3 kits, to St. Luke's IT for inventory. Furnish UPS with (1) AP7580 Row Extender, when 8-foot length PDU cords are not long enough to reach UPS based on Network Room layout and cabinet locations.

D. UPS shall have IP network connectivity for monitoring capability. Provide and install data patch cable from each UPS to a Network switch port. Coordinate port assignments with Owner's IT Representative.

2.4 COOLING UNITS

A. In ERs and DNRs where equipment heat load is greater than 2 kW, furnish In-Row Cooling as follows, with these units to be installed by the Mechanical Contractor:

1. Provide minimum quantity of (2) cooling units, (1) of which is for redundant / back-up use, for N+1 redundancy. Provide additional cooling units as heat load of equipment requires.
2. Provide APC # ACRC301S (Chilled Water) In-Row Cooling Unit, in sites where building chilled water is available year-round.

    a. Provide factory APC Start-up Service # WSTRTUP5X8-AX-26, with cooling units.

3. Provide APC # ACRD100 (Air) In-Row Cooling Unit in sites where building chilled water is not available year-round, but space and accommodations are available for corresponding roof-top condenser unit.

    a. Furnish roof-top condenser unit APC # ACCD75214, in quantity of one (1) condenser unit for each In-Row Cooling unit. Roof-top condenser unit shall be installed by Mechanical Contractor.
    b. Furnish with each roof-top condenser unit, Flooded Receiver APC # ACAC75009 and Isolation Valve Assembly APC # ACAC10022. Flooded Receiver and Isolation Valve Assembly shall be installed by Mechanical Contractor.
    c. Provide factory APC Start-up Service # WSTRTUP5X8-AX-15, with cooling units.

4. Provide APC # ACSC100-MM1 self-contained unit, where connection to air return plenum and cold air supply duct is available.

5. Provide APC ACRD200 Fluid Cooled in-row cooling unit where fluid cooler is used.

6. Provide data patch cable from each in-row cooling unit, to a Network switch port. Coordinate port assignments with Owner's IT Representative.

2.5 CAMERA WITH TEMPERATURE / HUMIDITY MONITORING

A. Provide one Camera / Monitor unit in each DNR and Equipment Room. Unit shall be Netbotz # NBWL0355. Locate unit generally so it monitors the door into the room; coordinate exact mounting location with Owner. Provide with data cable/connection back to patch panel port within same room.

2.6 PATCH PANELS

A. Provide separate Category 6A patch panels for Wireless Network Access Point cable terminations, patch panel by CommScope, 48-port 2-Rack Unit height model # CPP-UDDM-SL-2U-48 with (48) individual Category 6A jacks model # USL10G-BLK; and 24-port 1-Rack Unit height model # CPP-UDDM-SL-1U-24 with (24) individual Category 6A jacks model # USL10G-BLK, in quantity of patch panels to terminate all corresponding work area jacks plus minimum 20% spare capacity.

B. Provide separate Category 6 patch panels for all other Data, Voice, Patient Monitoring / Philips, and Bio-Medical terminations. Patch Panel by CommScope, 48-port, 2-Rack Unit height, model # CPP-UDDM-SL-2U-48 with (48) individual Category 6 jacks model # USL600-BLK; and 24-port 1-Rack Unit height model # CPP-UDDM-SL-1U-24 with (24) individual Category 6 jacks model # USL600-BLK, in quantity of patch panels to terminate all corresponding work area jacks plus minimum 20% spare capacity.

2.7 CABLE MANAGEMENT

A. Provide Horizontal Management Panels, one above each patch panel and below bottom-most patch panel. CommScope Model # 1933530-1 1U or 1933532-1 2U.

B. Provide two (2) Vertical Management Panels in each APC AR3150 cabinet, APC # AR7580A with cover APC # AR7581A.

2.8 LADDER RUNWAY

A. Ladder Runway in DNRs to be UL Classified, 18" Width with 9" rung spacing unless otherwise noted, Hoffman # LSS18BLK or approved equal.

B. Provide wall-mount brackets, Hoffman # LTSB18BLK and/or LWASK18BLK, supporting Ladder Runway on maximum 5-foot spans. Where wall-mounting is not available, utilize dual 3/8" minimum ATR with trapeze support, to building structure above, keeping ladder runway level / plumb throughout. Center-hung ceiling support shall not be allowed.

C. Provide insulated ground jumper kit at each junction of runway, Hoffman # DGJ or approved equivalent.

D. Provide UL-Classified Butt-Splice kit at each straight junction of runway sections, Hoffman # LBSKB or approved equal.

E. Provide UL-Classified 90-degree Junction Splice kit at each 90-degree junction of runway sections, Hoffman # LJSKB or approved equal.

F. Provide Radius Drop Kits, from runway rung or stringer as required, to transition cable bundle down into each vertical management section of Equipment Cabinets. Hoffman # LRD18BLK and LSRDBLK or approved equivalent.

2.9 COPPER HARDWARE

A. Terminate Analog Voice Backbone cables when indicated on drawings, on rack-mount 110-blocks, CommScope model # 558635-1. Locate panel near top of Network Patch / Cabling overflow equipment cabinet, just under fiber optic distribution enclosure.

2.10 FIBER OPTIC HARDWARE

A. Fiber Optic Rack Mount Distribution Enclosures shall be 2-Rack Unit or 4-Rack Unit height as required, CommScope SD-2U-FX and SD-4U-FX. Locate at top of Network Patch / Cabling overflow equipment cabinet.

B. Fiber Optic Splice Cassettes for Distribution Enclosures shall be 12-strand, 6-duplex LC, single-mode, CommScope PNL-CS-12LCW-PT, 24-strand PNL-CS-24LCW-PT.

2.11 PATCH CABLES

A. Provide CommScope Blue Category 6A Patch Cables for Wireless Network Access Point Terminations, # UNC10G, in DNR in lengths as required for neat / professional installation while avoiding excess slack. Quantity (1) for each Category 6A cable installed / terminated.

B. Provide in DNR, CommScope TE Category 6 Patch Cables for Data, Voice, Bio-Med, terminations (Blue patch cord color); and in Orange color for Patient Monitoring / Philips terminations, # UNC6, in lengths as required for neat / professional installation while avoiding excess slack. Quantity (1) for each Category 6 cable installed / terminated.

C. Provide 110-connector to RJ45 Category 5e patch cables for Analog Voice, from Category 6 Horizontal Cabling Patch Panel ports to 110-block Backbone Rack-mount backbone terminations. Patch Cables in 1- or 2-pair as required, coordinate with Owner, cables manufactured by QuikTron or approved equivalent.

D. Install all patch cables per coordination with Owner.

2.12 GROUNDING / BONDING

A. Electrical Contractor shall provide a telecommunications main ground busbar (TMGB) in each Entrance Facility or Equipment Room, and telecommunications ground busbar (TGB) in each DNR.

B. Electrical Contractor shall provide bonding connections from TGB to:

1. nearest building steel
2. equipment grounding bus of nearest electrical branch circuit panel
3. nearest section of cable tray in corridor outside DNR
4. each equipment cabinet and in-row cooling unit in the DNR

C. The TMGB and TGB shall meet the following specifications:

1. UL 467 Listed
2. Busbar shall be 4” high x 12” long and 0.25” thick, unless otherwise noted on drawings.

3. Include insulated mounting brackets.
4. Be packaged as a kit, with assortment of connecting lugs and tube of antioxidant.
5. Hoffman part number DGTB412 or approved equal.

D. Grounding / Bonding Conductors shall be No. 6 AWG stranded copper green insulated, for bonding lengths up to 100', unless otherwise noted on drawings. For lengths greater than 100 feet, reference BICSI TDMM Chapter 9 for calculating minimum grounding/bonding AWG size.

E. Provide additional 2-hole compression lugs for bonding to TMGB and TGBs as required, Hoffman series DGCL or approved equivalent.

F. Provide Lay-In Lug for bonding to Equipment Cabinets, Hoffman # DGLG or approved equivalent.

PART 3 - EXECUTION

3.1 EQUIPMENT ROOM (ER) AND DISTRIBUTIVE NETWORK ROOM (DNR) REQUIREMENTS

A. The typical campus consists of one or more fixed (or "permanent") buildings and may include a number of portable facilities. Typically, a permanent building shall contain a main equipment room (ER) with standing equipment cabinets, and one or more secondary distributive network rooms (DNRs) also with standing equipment cabinets. Each DNR shall be connected to the ER by a specified multi-strand, single-mode fiber optic cable. Each portable building or remote (clinic) location shall typically contain one DNR. With some exceptions, the DNRs in these facilities shall contain one wall-mounted rack ("half rack"), usually an enclosed half rack.

B. The DNRs shall be established (prior to the cabling contractor's walk through) by marking the suggested location on the floor plan drawing and confirming the location with the necessary Saint Luke's Health System personnel. There should be at least one DNR per floor of each building, and to the extent possible, this DNR should be located towards the center of the building.

C. Electrical distribution equipment and dry type transformers are never to reside in ERs or DNRs.

D. A minimum of one DNR shall be provided for every 10,000 square feet of finished building space served, and a minimum of one DNR shall be provided per floor of building. Requests for any exceptions must be made in writing to Owner's Representative.

E. Minimum Dimensions: DNR minimum room dimensions shall be:

1. 9.5-feet deep by 9-feet wide by when using ceiling-mount cooling unit. See additional criteria in this Specification for type of cooling unit in each DNR.
2. 10.5-feet deep by 10-feet wide when using in-row cooling units. See additional criteria in this Specification for type of cooling unit in each DNR.
3. Up to 18-feet deep by 16-feet wide, depending on the number and type of services to be provided from the DNR.
4. Minimum clearances from equipment cabinets to walls shall be: 3-feet to back of cabinets, 4-feet in front of cabinets, and 3-feet to at least one side of cabinets.
5. Coordinate room dimensions with Owner's IT Representative, and with Architect, early in design process to ensure adequate space for IT requirements.

F. Each ER location will require wall space (nominally 4’ by 8’) for telephone tie cables going to the current telephone switch and for future cross connect fields to the telephone switching equipment.

G. Typically, a 36” (width) by 42” (height) wall space will be needed for wall-mounted cabinets in portable and smaller remote facilities such as clinics. Service is from the front of the rack or, depending upon the rack, the equipment mounted in the wall-mount cabinet is serviced by swinging open a gate. A clear space of approximately 30” is necessary for clearance in front of the rack. Service clearance for the equipment mounted in standing racks is 36” front and back with adequate room to pass from front to back on at least one side.

H. DNR floor shall be at minimum, sealed concrete slab to minimize dust. DNRs containing server equipment shall have anti-static floor tile.

I. DNRs shall not include drop ceilings, unless otherwise indicated on drawings.

J. Cooling unit shall be sized in accordance with capacity of UPS in DNR.

K. The temperature shall be maintained within the manufacturer’s recommended operating temperature range for the selected network electronics equipment, nominally between 60 – 85 degrees Fahrenheit. Temperature control shall not deviate from set point by more than 2.5 degrees. The engineering firm shall be responsible for obtaining the heat load requirements from the Information Services department representative to determine the HVAC requirements. A temperature sensor shall be located in the center of each closet and monitored at the Lee Summit Data Center.

L. Humidity shall be maintained between 30% and 55%.

M. Supply/return ventilation for each enclosed space shall recirculate the room air at a rate of five times per minute.

N. Additional insulation shall be included in the walls to provide noise reduction for adjacent offices/work areas.

O. Lighting is required at the level of 50 foot-candles at 3 meters, which is approximately equivalent to three 100-watt incandescent fixtures. The lighting should be positioned to provide a normal desktop level of illumination to the equipment control panels.

P. Each ER and DNR must have 110v and 240v power. Three 20 Amp dedicated circuits must be provided to each ER, at least one of which shall be connected to an emergency backup power system. Two dedicated 20 Amp circuits must be provided to each DNR location, at least one of which shall be connected to an emergency backup power system. One dedicated 20 Amp circuit must be provided to each DNR in portable buildings and remote (clinic) locations. Standard 110v quad-plex wall outlets should be positioned on each wall, and a standard 240v quad-plex wall outlet shall be positioned as near as possible to a point approximately 12” in back of the centerline of the equipment rack at standard outlet height or located as detailed on the DNR floor plan drawing. The outlets should contain a color-coded designation of the circuit as a dedicated circuit.

Q. Dual-source power shall be provided to all equipment in ER and DNR: one feed from UPS located within the same room, and one feed from Normal Hospital Power.

R. UPS in DNR shall be sized based on power load requirements of initial equipment, plus 50 percent minimum spare capacity for growth.

1. Minimum 5 kVA capacity UPS shall be provided in small DNRs.
2. Typical DNRs will require minimum 8 kVA UPS, expandable to 16 kVA.

S. DNR shall have electronic access control reader for entry to room, tied to existing Pegasys system.

3.2 INSTALLATION

A. Physical connectivity shall be provided through a combination of Categories 6A, 6 and 5e Unshielded Twisted Pair (UTP), four-pair copper cabling; and single-mode fiber optic cable. All proposed copper cabling system components must meet Categories 6A, 6 or 5e performance specifications as indicated. All fiber optic connectivity must at a minimum meet 10 Gigabit Ethernet performance specifications.

B. All racks will be grounded according to EIA/TIA – 607 Commercial Building Grounding and Bonding Requirements for Commercial Buildings. A suitable connection to earth ground is required for each ER and DNR location within 20' of each wiring cabinet for grounding.

C. A camera with temperature and humidity monitoring shall be placed on each wall (wallbotz) to provide remote snapshots/viewing of activity in the room and shall be provided with a data port connected to a patch panel port within the room.

D. A wall-mount telephone outlet shall be provided inside the ER and DNRs near the door.

E. The installation of all data wiring shall meet the ANSI/TIA specifications for Categories 6A, 6 and 5e installations found in ANSI/TIA Standards 568 and 569. The contractor shall give careful attention to all the elements necessary to a quality installation. Particular attention should be paid to the following precautions:

1. The minimum bend radius of the cable must not be exceeded (nominally 8x the diameter of the cable, unless otherwise indicated by manufacturer).
2. The maximum tensile loading during installation must not be exceeded (25 lbf).
3. In dressing and routing the cables, the cable bundle must not be over cinched. Cable ties should not be tightened to the point that the cable jacket is compressed.
4. The cable must not be stripped back any farther than is absolutely necessary. The contractor should follow the manufacturer's specification for the cable being installed. A .5" maximum of exposed (stripped) cable is recommended.
5. The pair twists in the stripped cable should be maintained as close as possible to the point of termination. The twists must be maintained to within .5" from the point of termination.

F. A minimum of two floor mounted standing equipment cabinets shall be installed in each ER and DNR at the locations indicated on the floor plan drawing, (one dedicated for voice terminations and one dedicated for data terminations). Reference drawings to determine additional cabinets as required, for Data/Network Growth, Broadband/Cable TV, Security Equipment, Telemetry & Patient Monitoring, and Bio-Medical. If space restrictions shall not permit a full-size (7') equipment cabinet, a wall-mounted, half-rack (42") may be recommended. In the cases where the rack cannot be installed as a floor-mounted rack, for example, in a portable building or smaller closet, a wall-mounted rack shall be specified. The cabling contractor shall install the equipment racks. Open wall-mounted racks are specified in those locations where a separate, lockable, enclosed space, dedicated solely to telecommunications equipment, is provided. Enclosed, lockable cabinets shall be required in any multi-use area.

G. Closets containing one equipment rack shall be configured as follows and **shall only be used when directed by owner for remote non-Saint Luke's Campuses:**

1. FIBER OPTIC TERMINATIONS: The standing rack shall typically house the fiber optic terminations at the top of the rack,
2. VERTICAL (COPPER BACKBONE) TERMINATIONS: All vertical (backbone) Analog Voice cable terminations shall be located in Category 5e rack-mount 110-blocks below the fiber optic terminations at the top of the rack. Vertical copper backbone cabling will be specified on a per site basis and will not be used at all locations.
3. HORIZONTAL (DROP) TERMINATIONS: All horizontal (drop) cable terminations, shall be located in patch panels mounted below the fiber optic terminations and the vertical copper (backbone) connections (if any) at the top of the rack. Patch Panels for Data/VoIP shall be Category 6A; for Analog Voice shall be Category 5e.
4. VOICE CROSS CONNECTION PANELS: All Analog Voice locations shall be jumpered from the horizontal termination panels to a rack-mount Backbone 110-block. (Refer to rack diagram). Jumpering to the voice panels shall require RJ-45 to 110-connector jumpers.
5. DATA CROSS CONNECTION PANELS: All data locations shall be jumpered from the horizontal termination panels to network electronic equipment using a RJ-45 to RJ-45 patch cable. All patch cables (both equipment room and workstation ends) shall be provided and installed by contractor. Varible length patch cables shall be used in the equipment and telecommunication rooms to maintain a professional installation and look. Typically 10 foot patch cables will be provided and installed at the workstation end. All patch cables shall meet requirements as set forth in this specification.
6. NETWORK EQUIPMENT (Provided and installed by Information Services): The electronic equipment shall typically be mounted directly below the voice and data cross connection panels. Cable management brackets shall separate each patch panel or hub from the next.

H. Vertical management shall be utilized in Network Patch / Cabling and Network Patch / Cabling overflow equipment cabinets for neat and professional cable management. Wall-mounted racks shall have a vertical wire management panel attached to each side. Horizontal cable management shall be accomplished by the use of one horizontal, rack-mounted wire management panel above each 48-port patch panel, and below bottom-most patch panel.

I. All cabinets and racks shall be grounded according to ANSI-J-STD-607(A) Commercial Building Grounding and Bonding Requirements for Commercial Buildings.

J. A ladder runway assembly shall be used to stabilize all standing cabinets / racks. Ladder runway shall be installed according to the floor plan drawings to stabilize all standing racks and provide cable routing in the wiring closet.

K. The Saint Luke's Network Engineering Standard for all DNRs supports installing a minimum of three floor mounted cabinets, one dedicated for network equipment and cabling, one for network equipment and cabling overflow, and one for miscellaneous equipment such as bio-medical and security. (One-cabinet or two-cabinet configurations are only used when directed and for non-Saint Luke's Campuses):

L. Cable rollers shall be used when pulling cable. Cable pulleys must be used when pulling cable around bends and corners of wireways. Pulleys shall have a minimum diameter of six inches, so as not to exceed the allowable bend radius of the cable. Contractor shall use basket grips wherever possible, and exercise care while pulling cable so as not to exceed the maximum allowable pulling strength of the cable. Saint Luke's Health System requests that the bidder make every effort to conceal all new cables installed as part of the project. Where impractical or

impossible to run cables in ceilings and walls, the bidder should include surface mount raceways or power poles. Pull strings shall be left in each wire routeway.

M. The contractor is responsible to determine the lengths and routing of the copper cable to be installed by examining the floor plan and site drawings and becoming acquainted with the local conditions during the site walk through. Drop lengths should not exceed 90 meters in order to allow the total length of the run, including jumpers at both ends to fall within the 100-meter standard for Category 6A installations.

1. Managing cable lengths is essential to overall system integrity. The cable shall be routed as shown on the drawings. The contractor shall make every effort to conceal all new cables installed as part of the project. Where impractical or impossible to run cables in conduit, ceilings and walls, the contractor shall include surface mount raceways or power poles.

N. The contractor should treat each penetration of partitions as a fire penetration to be sleeved and stopped according to NEC and NFPA requirements. Nelson fire protection materials are suggested as an acceptable firestopping material. All materials chosen must meet both national and local codes. It is understood that all areas above the ceiling line are treated by local codes as plenum areas. The contractor should prepare to make all necessary penetrations in non-asbestos areas assuming all drilling shall require continuous vacuum during drilling and immediate paint seal precautions following drilling. The contractor must adhere to all local, state and federal regulations in making any core hole penetration. Saint Luke’s Health System shall be responsible for all penetrations in areas determined to be asbestos contaminated. Under no circumstances shall the contractor core drill an asbestos contaminated penetration.

O. Bidders shall be required to submit test results for each cable in both hard and soft copy. This testing must be performed with a Category 6A test device, such as a Fluke Versiv or equivalent tester. Test documentation must include signal frequency (to 500MHz), length of the cable as installed and pass/fail results. Each cable shall be tested for Pin-to-Pin Continuity, Near End Crosstalk (NEXT), Attenuation and Impedance.

P. All fiber optic connections shall be "home runs" from the DNRs to the ER. Each DNR shall be connected to the ER through the use of two each single-mode fiber optic cables that have redundant paths into the closet. All termination facilities shall be fusion-splice type, and shall be rack mounted. The fiber routed within the building shall be plenum rated and armored, and secured above the existing mechanical members in the ceilings wherever possible. The fiber running outside the building shall be outdoor rated (indoor-outdoor is acceptable) and shall be run outdoors overhead in innerduct over lashed to allow for pulling back the fiber cable if a portable building is moved. Single runs may use aerial (strengthened) fiber cable without innerduct. Poles, masts and weatherheads shall be installed as necessary to preserve a star-wired topology. Multiple strands shall be distributed to a central location and star-wired from there to the final destinations (hierarchical star topology) only at designated sites. In these, primarily multi-campus, environments (geographically contiguous), the fiber strands shall jumper through an intermediate wiring facility, preserving the "home run" to the ER. But these are the exception to the rule. All cable used both indoors and outdoors must be plenum rated cable. Acceptable equivalents are noted. Transition splices to a loose tube plenum cable for indoor use are specified where necessary to meet the 50’ building entry NEC code requirements.

Q. Screw cover pull boxes (standard electrical enclosures) are specified for containing the fiber optic cable at the point of building entry as necessary. The enclosure must be of sufficient depth to maintain the bend radius of the fiber as it passes through the enclosure from any side. A minimum 12"x12"x6" enclosure is specified. Care must be taken to preserve the bend radius of the fiber passing through the pull box.

R. Metallic (EMT) conduit is specified from the pull box to the equipment rack location in all buildings where the building entry point occurs in a stairwell or at a distance greater than 50' from the termination facility.

S. 1-1/4" innerduct is acceptable for routing the fiber from the pull box to the equipment rack location in all buildings where the entry point is not in a stairwell of the building or is less than 50' from the termination facility. NOTE: The distance from the point of building penetration to the wiring rack termination of the fiber cable must be 50' or less for the use of innerduct. Aerial duct may be used to provide a channel for pulling back the fiber optic cable in the event that a portable facility is moved. A product equivalent to the Carlon Aerial Conduit (1" or 1 ½") is recommended.

T. Care must be taken in the installation of the fiber optic cable to complete the installation with as little stress as possible to the fibers themselves. In particular, attention should be paid to the following:

1. The contractor should meter the pulling force being applied whenever necessary in order to insure that the manufacturer's specification for tensile loading during installation is not being exceeded. When two or more cables are installed at the same time, the total pulling tension is reduced by 20% from the maximum pulling tension of the lowest rated cable being installed.
2. Care should also be taken to maintain the minimum bend radius specified by the manufacturer (nominally 10x the diameter of the cable). The contractor is responsible to insure the correct bend radius of the cable and maintain sufficient caution in all pulls to insure the bend radius is not exceeded. The contractor is expected to inspect all bends in any new or pre-existing conduit to be used as a cable route to assure that he is not pulling the cable through a conduit with too small a bend radius. Similarly, no fiber optic cable should be bent, kinked or knotted in any application.
3. Crush and impact considerations require that the optical fiber cable be protected from force or pressure exerted on the cable. The fiber should be placed in innerduct, even when in conduit, and installed above heavier cables out of the traffic flow. Within each building the fiber, in innerduct should be mounted to fixed roofing supports as high in the ceiling space as possible and practical to avoid possible breakage which may occur when other mechanical plant service is being performed in the ceiling. Where existing conduits are available as a path but are not large enough to allow the placement of inner duct along with the necessary fiber counts, the contractor should take care to pre-plan, making sure of the number and length of the individual cables to be pulled and pulling them all at once.

U. The contractor is responsible to determine the lengths and routing of the fiber optic cable to be installed by examining the floor plan and site drawings and becoming acquainted with the local conditions prior to installation. A 20' service loop shall be provided at each ER and DNR location. Smaller loops (minimum 3'), as practical should be provided at the point of building exit and entry. Cable lengths to the portable buildings and other external buildings should anticipate the worst case rack location and provide a 20' service loop at that location if possible.

V. Fiber routing (as indicated during the walkthrough of each facility) shall allow for the building entry to be within 50' of the rack location in the vast majority of cases. In the few locations where the fiber enters the building more than 50' from termination, conduit has been specified from the point of entry to the rack location. In any case therefore, fiber splices at locations outside of ER and DNRs can and should be eliminated. In the extreme case where a splice is necessary, fusion splices are specified with a maximum allowable degradation of less than 1 dB. No splices should be made without consulting the project manager and computing the effect upon the link loss budget.

W. Fiber optic cable labels should detail the wiring closet and patch panel port for each fiber strand. The labels should contain both source (this ER/DNR and patch panel) and destination information so that from any end location the termination port of the other end is known. The installation should be “parallel” from ER to DNR with the fiber strands terminated on corresponding port locations in each closet as much as possible. The fiber strands should be labeled on the patch panel or termination facility at both ends. The fiber bundles should be clearly marked on both ends at a point within the wiring closet before the sheath is stripped and the individual strands broken out for termination.

X. Proper testing of the installed cabling is necessary to ensure a quality product. Each individual optical fiber cable shall undergo end-to-end attenuation testing measuring the optical power loss between cable termination points, including cable connectors and splices. End-to-end testing shall be conducted at both the 850nm and 1300nm windows on multimode, and 1300nm and 1550nm on single-mode. The testing of single-mode shall be done using both a light source and power meter method and an OTDR to provide a visual display of the location of individual components as well as the attenuation losses for those components. All fibers should be tested in both directions at both wavelengths. The contractor shall follow manufacturer's instructions for test setup, implementation and recording of results. Acceptable dB loss shall be calculated in a link-loss budget prior to installation.

Y. Ensure that equipment cabinets and racks are properly grounded and stable. Provide and install ladder runway assembly in the ER / DNR according to the floor plan drawing to establish perimeter routing and to stabilize the racks. Triangular support brackets will support perimeter routing.

Z. Provide and install the appropriate Fiber Distribution Center or modular patch panel with cassettes for fiber splicing and patching in top of the rack as indicated in the rack elevation diagram. Provide and install the appropriate number of Categories 6A, 6 and 5e RJ-45 patch panels for horizontal (drop/station) terminations in the rack. Provide and install the appropriate number of Category 5E RJ-45 patch panels in the rack for voice connection to the phone switch or cross connect blocks.

AA. Provide and install the appropriate number of cable management brackets to service the patch panels and switches needed for each location.

BB. Workstation horizontal cables shall be routed through the walls and ceiling where possible and installed in PVC raceway attached to the wall or baseboard when wall or ceiling access is unavailable. Leave a service loop of 10’ of cable coiled in the ceiling near the rack location.

CC. Provide and install the appropriate bundled tie cables between wiring closets, from the ER to each DNR as specified. The tie cables shall be terminated on rack-mount 110 blocks.

1. Cross connect the backbone (tie) cable from the 110 blocks to the RJ-45 voice connection panels using patch cables as specified.
2. Provide and install the appropriate number of tie (backbone) connection cables (bundled tie cables as specified by site) complete with surge suppression (as necessary) to each of the separate portable or permanent buildings housing DNRs at each site. Provide and install, as above, the necessary jumpers and cross connects to provide 2-pair connection back to the ER for each Analog voice drop in the separate permanent or portable buildings.

DD. Provide and install the appropriate number of fiber optic strands between the ER and each DNR or "mini-DNR" (portable building). The contractor is responsible for all necessary aerial suspension facilities including poles, towers, masts, guy wires, pull boxes, innerduct and so on.

1. Test each fiber strand against the stated specifications and provide hard and soft copy test results to the project manager.

EE. Data / Voice Contractor is to provide Grounding / Bonding connections from TMGBs and TGBs, to:

1. Ladder runway
2. Cable shields and surge protection / building entrance terminals associated with outdoor cables which that Contractor installs

Electrical Contractor is to provide Grounding / Bonding connections from TMGBs and TGBs to:

1. Equipment ground terminal bus in nearest ac electrical distribution panel board
2. Nearest structural building steel, whether vertical or horizontal beam, if available.
3. Nearest section of cable tray outside DNR.
4. Each equipment cabinet and in-row cooling unit in the DNR.

Per BICSI TDMM Chapter 9 Bonding and Grounding (Earthing), a Telecommunications Grounding Backbone between TGBs and TMGB is not required due to the high impedance associated with long lengths of bonding conductor between rooms.

END OF SECTION

SECTION 27 11 50

TELECOMMUNICATIONS PATHWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. This Section includes:

1. Pathways.
2. Cable Hangers and Supports, Tie Wraps.
3. Innerduct, Corrugated.
4. Firestopping Systems, which are to be furnished and installed by the Firestop Contractor.

1.3 REFERENCE STANDARDS

A. All regulations and references shall be as specified in Section 27 05 00.

1.4 SUBMITTALS

A. All submittals shall be as specified in Section 27 06 00.

B. A copy of the BICSI RCDD certification as specified in Section 27 07 00 shall be submitted for approval.

C. A copy of all Installer Certifications (whom will work on this project) from the manufacturer of the Infrastructure Cabling System shall be submitted for approval. The Certificate shall indicate the level of certification achieved by the installer.

1.5 QUALITY ASSURANCE

A. Install all products in accordance with the manufacturer’s instructions.

B. Manufacturer: The equipment shall be manufactured by a firm engaged in the manufacture of pathway systems hardware for a period of at least 5 years.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Typically, the electrical contractor shall install all conduits, wire ways, cable tray and surface metal raceway for use by this Contractor. However, any pathways not provided under the electrical contract and required for a fully functional network cabling system, shall be supplied and installed by this Contractor.

B. Sleeves shall be sized two times larger than what is presently required for future use.

2.2 CABLE HANGERS AND SUPPORTS, TIE WRAPS

A. Cable hangers shall be specifically designed and manufactured for high performance network cabling systems. They shall have an extra wide base to provide cable support on a flat surface, eliminating kinking, bending and crimping of the network cable. All cable hangers shall come packaged with a steel beam clamp attached to the cable hanger with a ¼" steel bolt for supporting to structural steel. Cable hangers shall be Erico Caddy J-hook part number CAT64, CAT32, CAT21, CAT12, or approved equals by B-Line. Size J-hooks to provide 30% spare capacity for future cable adds.

B. Tie wraps used in Distributive Network Rooms (DNRs) shall be Velcro-type cable ties to prevent over tension and to allow for reuse in the event of future adds moves or changes. Velcro cable ties shall be as manufactured by Panduit or approved equal.

C. Tie wraps used in all other areas shall be self-locking and natural nylon color cable ties, UL Listed for use in air handling spaces per NEC. Cable ties shall be Panduit, Series PLTxS-C in the length required or approved equal.

D. Innerduct, Corrugated:

In most cases armored indoor fiber is specified, eliminating need for indoor innerduct. However, refer to drawings and where indicated provide innerduct per the following requirements.

1. Plenum Rated:

   a. Plenum innerducts shall be corrugated, communication orange in color, have a pull tape pre-installed, meet the IPS dimensions, comply with TIA-569, UL 910, NEC 770-53 plenum and have footage sequentially marked. Plenum innerducts shall be Carlon Telecom Systems part number 16108-xxx or approved equal by Endot Industries.
   b. Innerduct shall be sized as noted on the drawings.

2. Outside Plant:

   a. General purpose innderducts shall be corrugated, communication orange in color, have a pull line pre-installed, meet the IPS dimensions, comply with TIA-569, UL 94V-0, NEC 770-53 general purpose and have footage sequentially marked. Outside plant innerducts shall be suitable for direct burial and plowing applications. Outside plant innerducts shall be Carlon Telecom Systems part number 14108xx-xxx or approved equal by Endot Industries.

b. Innerduct shall be sized as noted on the drawings.

E. Firestopping Systems:

1. Pre-manufactured sleeve assemblies with built-tin firestopping are required at all cable penetrations through walls, and shall be by ST1, EZ Path series, furnished and installed by the Firestop Contractor.
2. All fire stop material shall be by a single manufacturer, furnished and installed by the Firestop Contractor, and shall comply with the following:

   a. ASTME-814, Standard Method of Fire Tests of Through-Penetration Fire Stops.
   b. UL 1479, Fire Tests of Through-Penetration Fire Stops.
   c. U.L. Fire Resistance Directory: Through Penetration Fire Stop Devices (XGCR) and Through Penetration Fire Stop Systems (XHEZ).
   d. ULC List of Equipment and Materials, Vol. II.

3. Designs selected for installation shall provide a fire resistance rating at least equal to the hourly resistance rating of the floor, wall or partition into which the fire stop design will be installed.
4. Fire stop systems and materials shall not require special tools for installation and shall not emit hazardous, combustible or irritating fumes during installation, curing or use.
5. When more than one fire stop design is applicable, individual product characteristics should be evaluated for secondary benefits in performance, e.g. environmental/water sealing, or ease of installation or modification.
6. Installation shall conform to requirements of qualified designs or manufacturer approved modification, as supported by engineering reports and accepted by the authority having jurisdiction.
7. Manufactured assemblies and material formulations shall be prepared under a third party monitored Quality Control Program, e.g., U.L. Follow-up Service.
8. Fire stop products shall be as manufactured by Nelson Firestop Products, a Unit of General Signal or approved equal as follows:

   a. Nelson FSP, Flameseal: A ready to use, permanently pliable intumescent putty.
   b. Nelson CLK: A one part, silicone based, non-sagging, adhesive sealant.
   c. Nelson CMP: A non-slump, cementitious sealant.
   d. Nelson PLW: A ready to use, intumescent fibrous material enclosed in a strong polyethylene envelope.
   e. Nelson RSW: Intumescent coated mineral wool strips which may be used in conjunction with CLK.
   f. Nelson CTG: A highly intumescent, water based, fire protective coating suitable for use on electrical power, control and communications cables.
   g. IPC International: KBS Sealbags System, re-usable heat expanding pillows or bags.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pathways:

1. Comply with ANSI/TIA-569-B and BICSI TDMM guidelines for separation from potential EMI sources, including electrical power lines and equipment, maintaining throughout

communications pathways the following minimum separation distances from EMI sources exceeding 5 kVA:

Condition	Minimum Separation Distance
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways	24 inches
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway	12 inches
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway	6 inches
Electrical motors and transformers	47 inches

The following separation requirements shall also be followed throughout communications pathways.

Source of Disturbance	Minimum Separation (inches)
Fluorescent lamps	6
Neon lamps	6
Mercury vapour lamps	6
High-intensity discharge lamps	6
Arc welders	31.5
Frequency induction heating	39.5

B. Cable Hangers and Supports, Tie Wraps:

1. Cable supports (J-hooks) shall be installed where required to properly manage cables not supported by cable tray and or conduit.
2. Cable supports must be attached to the structural steel. It shall not be permissible to install J-hooks on any support installed by another trade for their use such as ceiling drop wires and or acoustical tile ceiling grid.
3. Cable supports shall be spaced a maximum of 4’-0” apart.
4. Velcro cable ties must be used to manage cabling in all cable management troughs in every DNR. Velcro cable ties shall be used for management of the backbone, station and patch cord cabling.
5. All cable ties shall be installed “loosely” and shall not be cinched tight to prevent any damage and/or stress to cabling.

C. Innerduct, Corrugated:

1. All innerducts installed inside any building shall be plenum rated.
2. All innerducts installed in underground conduits shall be general purpose rated as defined by NEC 770-53.
3. Innerduct shall be installed for all fiber optic cabling and as shown on the drawings.
4. Innerducts shall be managed into the side cable management troughs of all equipment racks and onto backboards.
5. Innerduct shall be sized as noted on the drawings.

D. Firestop Systems:

1. Identify all locations requiring firestopping.
2. Storage of products shall comply with manufacturer’s requirements for each product.

3. Comply with recommended procedures, precautions or remedies described in Material Safety Data Sheets as applicable.
4. Schedule installation of firestopping by Firestop Contractor after completion of cable, innerduct and runways, but prior to covering or concealing of openings or elimination access thereto.
5. Install penetration seal materials in accordance with the design requirements and manufacturers' instructions.
6. Fire stop systems shall be installed in all openings and around all penetrating elements or devices as required by these Contract Documents, and as required by applicable design, building and construction codes, subject to the interpretation of the authority having jurisdiction.
7. All firestopping compounds applied to cables (e.g., inside existing legacy sleeves which lack integrated built-in firestop material), shall be non-hardening and reusable. Hardening caulks are not acceptable due to damage caused to cable sheaths when compound is removed for future cable adds and maintenance.
8. Follow design requirements pertaining to cable separation.
9. Follow manufacturer's recommendations to obtain a smooth, professional finish.
10. Complete and affix a firestop label on wall, both sides, next to firestopped penetration. Label shall include type of UL Assembly installed, name of Technician, name of Contractor Company, and date firestop installed.
11. Remove equipment, materials and debris, leaving area in a clean undamaged condition.
12. Schedule a final inspection with the Owner, Architect and the local Fire Marshal to verify all firestopping and sealing requirements are approved and complete.

END OF SECTION

SECTION 27 12 00

INFORMATION TECHNOLOGY GROUNDING

PART 1 - GENERAL

1.1 All Information Technologies Equipment and raceways shall be properly grounded in accordance with ANSI/TIE/EIA-607, the NFPA 70 (National Electrical Code) and all other applicable codes and regulations.

Reference Section 27 11 00 Distributive Network Rooms for additional requirements.

1.2 The major components of the telecommunications grounding and bonding infrastructure are as follows:

A. The bonding conductors for telecommunications.

B. The Telecommunications Main Grounding Busbar (TMGB).

C. The Telecommunications Grounding Busbar (TGB).

D. The conductors used to bond the components to the TMGB and the TGBs.

PART 2 - PRODUCTS

2.1 THE BONDING CONDUCTOR FOR TELECOMMUNICATIONS.

A. The bonding conductor shall bond the TMGB to the service equipment (power) ground.

B. A minimum of 300 mm (1 ft) separation shall be maintained between this insulated conductor and any DC power cables, switchboard cable, or high frequency cables, even when isolated by metallic conduit or EMT.

C. The minimum size for this conductor shall be 3/0 green installed stranded copper cable.

2.2 THE TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB).

A. The Telecommunication Main Grounding Busbar (TMGB) serves as an extension of the building grounding electrode system for telecommunications infrastructure, and is located such that it is accessible to telecommunications personnel.

B. The MDF or Telecommunications Entrance Facility (TEF) / Demarc Room is the desirable location for the TMGB. This TMGB may serve as the TGB for collocated equipment in the MDF.

C. The TMGB should be located so that the bonding conductor for it is as short and straight as possible.

D. The TMGB should be located to result in the straightest route considered the total length of the bonding conductor from the telecommunications primary protectors to the TMGB.

E. The TMGB shall be located near the backbone cabling and associated terminations.

F. The TMGB shall be as close to the Data Racks as practicable and shall be installed to maintain clearances required by applicable electrical codes.

G. Telecommunications primary protectors on the inter-building backbone cables shall be bonded to the TMGB.

H. The TMGB is the common point in the MDF to which all grounding connections for that room are made.

I. The TMGB is intended to be the location for connecting grounding bars incorporated in telecommunications equipment located in the TEF (e.g., MUX or optical fiber termination equipment).

J. The connections of bonding conductors to the TMGB shall utilize listed 2-hole compression connectors, exothermic type welded connections, or equivalent.

K. The TMGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used.

L. The TMGB shall have minimum dimensions of ¼" thick x 4" wide and 12" in length. The length may need to be adjusted longer to meet the application requirements with consideration of future growth.

M. It is required that the busbar be electrotin-plated for reduced contact resistance. The TMGB shall be insulated from its support. A 50 mm (2 in) separation is required.

N. The TMGB shall be insulated from its support. A 50 mm (2 in) separation is required.

2.3 THE IDF TELECOMMUNICATIONS GROUND BUSBAR (TGB).

A. The TGB is the common central point of connection for telecommunications systems and equipment in the location served by that IDF or equipment room.

B. Each IDF and equipment room shall contain a TGB.

C. The TGB should be located near the backbone cabling and associated terminations.

D. The TGB should be located so that the grounding conductors are as short and straight as possible.

E. The TGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used.

F. The TGB shall have minimum dimensions of ¼" thick x 4" wide and 12" in length.

G. It is required that the busbar be electrotin-plated for reduced contact resistance.

H. The TGB shall be insulated from its support. A 50 mm (2 in) separation is required.

2.4 BONDING CONDUCTORS

A. Bonding to the metal frame of a building:

1. All bonding conductors and connectors for bonding the metal frame of a building shall be listed for the purpose intended and approved by a NRTL.
2. In buildings where metal frames (structural steel) are effectively grounded, each TGB shall be bonded to the metal frame within the room using a No. 6 AWG conductor.
3. Where the metal frame is external to the room and readily accessible the metal frame should be bonded to the TGB with a No. 6 AWG conductor.
4. Where the metal frame is external to the room and readily accessible the metal frame should be bonded to the TMGB with a No. 6 AWG conductor.
5. When practicable because of shorter distances and other considerations, and where horizontal steel members are permanently electrically bonded to vertical column members, TGBs may be bonded to these horizontal members in lieu of the vertical column members.
6. This Standard does not require the steel bars of a reinforced concrete building to be bonded to the TGB or TBB.

B. The Telecommunications Bonding Backbone (TBB).

1. A TBB is a conductor that interconnects all TGBs with the TMGB. Per BICSI TDMM Chapter 9 Bonding and Grounding (Earthing), a TBB between TGBs and TMGB is not required due to the high impedance associated with long lengths of bonding conductor between rooms.

C. All bonding conductors and connectors shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL).

D. All bonding conductors shall have green insulation and be copper. The minimum bonding conductor size shall be a No. 6 AWG.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Route ground conductors to provide the shortest, most direct path from point to point.

B. Bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place bonding conductors in ferrous metallic conduit that exceed 1 m (3 ft) in length, the conductors shall be bonded to each end of the conduit with a conductor sized as a No. 6 AWG, minimum (this makes the conduit a parallel path with the cable).

C. Splices in bonding or grounding conductors are not allowed.

D. A continuous ground path shall be provided in all telecommunications raceways.

E. The IDF protector frames shall be grounded to the TGB.

F. At each IDF all equipment and raceways must be bonded to the TGB.

G. Any grounding or bonding conductor which is run through a metallic conduit shall be bonded to the conduit at both ends.

H. Gas pipes must not be utilized as a grounding electrode.

END OF SECTION

SECTION 27 13 00

BACKBONE CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes:

1. Fiber Optic Backbone.
2. Copper Backbone (Analog Voice).
3. Fiber Optic Connectors.
4. Grounding and Bonding.

B. Refer to project drawings for backbone cabling components required, and sizing / quantities thereof.

1.3 REFERENCE STANDARDS

A. All regulations and references shall be as specified in Section 27 05 00.

1.4 SUBMITTALS

A. All submittals shall be as specified in Section 27 06 00.

B. A copy of the BICSI RCDD certification as specified in Section 27 07 00 shall be submitted for approval.

C. A copy of all Installer Certifications (who will work on this project) from the manufacturer of the Infrastructure Cabling System shall be submitted for approval. The Certificate shall indicate the level of certification achieved by the installer.

1.5 QUALITY ASSURANCE

A. Install all products in accordance with the manufacturer’s instructions.

B. The manufacturer of the cabling system being installed shall have trained the Contractor’s installers; said installers shall have at least 2 years experience in the installation of Infrastructure Cabling Systems.

C. Manufacturer: The network cabling equipment shall be manufactured by a firm engaged in the manufacture of network cabling systems for a period of at least 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fiber Optic Cable:

1. CommScope
2. Belden
3. General Cable

B. Voice Category 5e and Category 3 Backbone Cables:

1. CommScope
2. Belden
3. General Cable

2.2 FIBER OPTIC BACKBONE

A. Distribution Plenum Composite Fiber Optic Cables shall consist of two subunits bound together by a PVC outer jacket. Each subunit shall contain tight-buffered fibers surrounded by aramid strength members and a PVC jacket. The cable shall have a UL-Listed NEC rating of OFCP (Plenum). The outside jacket of the cable shall be sequentially marked showing length in feet and/or meters. High performance single-mode fibers shall meet all applicable industry performance standards as follows:

1. 900 um tight buffer coating allowing for easy connectorization and strip ability.
2. TIA color-coded fibers for easy identification.
3. Interlocking aluminum armor for indoor applications.
4. All-dielectric (non-armored for outdoor applications).
5. Aramid yarn reinforcement for rugged protection.
6. Designed and tested in accordance with ANSI/TIA-568, ISO 11801, Telecordia GR-409-CORE, Telecordia GR-20-CORE, and IEC 793-1/794-1.
7. Performance shall be as follows:

   The cable jacket shall be yellow for single-mode. The cable shall comply with the performance requirements listed in Table-1.

	Single-Mode (1300/1550nm)
Maximum Attenuation dB/km	0.5/0.5 (Indoor cable) 0.4/0.3 (Outdoor cable)
10 Gigabit Ethernet Distance	10,000 m / -

TABLE-1

BACKBONE DATA CABLE PERFORMANCE CHARACTERISTICS

B. Cables shall typically be 24-strand, unless otherwise noted on drawings.

1. Indoor Plenum Armored, CommScope Part # P-024-DZ-8W-FSUYL
2. Indoor / Outdoor All-Dielectric Plenum, CommScope Part # P-024-OD-8W-FSUBK

C. Provide fan-out buffer tube kits for terminating Indoor / Outdoor loose tube fibers, Corning FAN-BT25-12 or approved equal.

2.3 COPPER BACKBONE (VOICE)

A. Provide Copper Voice Backbone cable(s) when indicated on drawings. Not all projects will require Copper Voice Backbone cables.

B. Underground Gel-Filled Backbone Voice Cable shall be used in underground conduits and shall meet the following specifications:

1. The conductors shall be solid annealed bare copper 24 AWG (0.5mm).
2. The insulation shall be polyolefin color coded in accordance with standard industry code.
3. The twisted pairs shall be individual conductors twisted into pairs with varying lays to minimize crosstalk and with specified color combinations to provide pair identification.
4. The cables having 25 pair or less shall be assembled in a single group. Cables having more than 25 pairs shall be assembled in units, each individually identified by color-coded unit binders. The interstices between the pairs shall be filled with an 80*C filling compound.
5. The core covering shall be non-hygroscopic dielectric tape.
6. The shield shall be SEALPIC-F, electrically continuous 0.008 in. (0.2mm) thick polymer coated, corrugated aluminum tape applied longitudinally with overlapped edges and flooded with flooding compound.
7. The jacket shall be black polyethylene.
8. The manufacturer’s identification, pair count, conductor size, year of manufacture, and telephone handset shall be surface marked on the jacket at two-foot (610mm) intervals. Sequentially numbered length markings shall be located at alternate two-foot intervals.

C. Indoor Plenum Backbone Voice Cable shall be used inside the building in cable tray and conduits and shall meet the following specifications:

1. The cable shall be Category 5e rated, 25-pair.
2. The conductors shall be solid annealed bare copper 24 AWG (0.5mm).
3. The insulation shall be low smoke PVC.
4. The jacket shall be low smoke fluoropolymer with a UL flame rating of UL and cUL listing MPP/CMP.
5. The cable shall be in compliance with UL 444, UL 910 ANSI/ICEA S-90-661, ANSI/TIA/EIA 568-C and FCC Part 68.
6. The manufacturer’s identification, pair count, conductor size and year of manufacture shall be surface marked on the jacket at two-foot (610mm) intervals. Sequentially numbered length markings shall be located at alternate two-foot intervals.
7. Indoor Plenum Backbone Voice Cable shall be as manufactured by CommScope or approved equal.

2.4 FIBER OPTIC CONNECTORS

A. In lieu of fiber optic connectors, fiber optic cable strands shall be terminated via fusion-spliced cassettes with pig-tails. Reference Specification 27 11 00 Distributive Network Rooms.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate and sequence all work in accordance with the schedule established by the Architect and the lead Prime Contractor.

B. Equipment shall not be installed in dusty and unclean work areas. If equipment is installed and there is still risk of damage to the equipment, this Contractor shall protect and cover all materials and equipment to prevent any damage. All finishes and products shall be protected at all times.

3.2 INSTALLATION

A. Backbone Cable installation shall comply with the following:

1. Each Distributive Network Room (DNR) shall be connected to the Equipment Room (ER) through the use of two each single-mode fiber optic cables that have redundant / separate paths into the closet. All termination facilities shall be rack mounted, reference Section 271100 “Distributive Network Rooms.”
2. Cables routed within the building shall be plenum rated, and secured above the existing mechanical members in the ceilings wherever possible.
3. Cables running outside the building shall be outdoor rated (indoor-outdoor fiber optic cable is acceptable).
4. Fiber optic cable to be run outdoors overhead shall be in innerduct over lashed to guy wire to allow for pulling back the fiber cable if a portable structure is moved. Single runs may use aerial (strengthened) fiber cable without innerduct.
5. All fiber runs should be considered "home runs" from the DNRs to the ER unless otherwise specified. Poles, masts and weatherheads shall be installed as necessary to preserve a star-wired topology. Multiple strands shall be distributed to a central location and star-wired from there to the final destinations (hierarchical star topology) only at designated sites. In these, primarily multi-campus, environments (geographically contiguous), the fiber strands shall jumper through an intermediate wiring facility, preserving the "home run" to the MDF. But these are the exception to the rule.
6. All cable used both indoors and outdoors must be plenum rated cable. Acceptable equivalents are noted.
7. Transition splices to a plenum cable for indoor use are specified where necessary to meet the 50’ building entry NEC code requirements.
8. Backbone cables shall be installed and bundled separately from horizontal distribution cables.
9. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits or in separate innerducts within conduits.
10. Where backbone cable and distribution cables are installed in a cable tray or wire way, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
11. Cables shall be dressed and terminated in accordance with the recommendation made in the TIA/EIA-568-C documents, manufacturer’s recommendations, and/or best industry practices.
12. Bend radius of the cable in the termination area shall not exceed 15 times the outside diameter of the cable during installation and 10 times the outside diameter of the cable after installation, or minimum recommendations by cable Manufacturer, whichever is greater.
13. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each backbone cable shall be neatly bundled and dressed to his or her respective panels or

blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the frame.

14. The cable jacket shall be maintained as close as possible to the termination point.
15. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundled support ties. Cables labeled within the bundle where the label is obscured from view shall not be acceptable.
16. Fiber slack shall be neatly coiled within the fiber termination panel or enclosure, six-foot minimum.
17. Provide 20' service loop at both ends of cables, supported on ladder runway overhead.
18. Each cable shall be individually attached to the receptive termination panel by mechanical means. The cable's strength member(s) shall be securely attached to the cable strained relief bracket in the panel.
19. Each fiber cable shall be stripped upon entering the termination panel and the individual fibers routed in the termination panel.
20. Each fiber optic cable shall be terminated via fusion-splice cassettes in the MC, IC and TCs in 24 or 48 port rack mount fiber enclosures as shown on the drawings.
21. Break out kits shall be installed on all Dual Rated Indoor / Outdoor rated fiber. The break out kits shall increase the coating on the terminated fiber cable to 900 micron. Breakout kits shall be installed in accordance with the manufacturer's written instructions.

B. Fusion splicing shall be completed in accordance with the fusion splicer manufacturer's written instructions.

C. The grounding and bonding system shall be installed in accordance with the following:

1. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in an ER or DNR MC, shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.
2. All wires used for telecommunications grounding purposes shall be identified with a green insulation. All cables and bus bars shall be identified and labeled in accordance TIA/EIA - 606.

END OF SECTION

SECTION 27 15 00

HORIZONTAL CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Special Conditions”, “General Conditions”, “Supplement to the General Conditions”, and Division 1 Specifications Sections, form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes:

1. Categories 6A and 6 Plenum Cable.
2. Faceplates and Jacks.
3. Patch Cords at Work Areas.

1.3 REFERENCE STANDARDS

A. All regulations and references shall be as specified in Section 27 05 00.

1.4 SUBMITTALS

A. All submittals shall be as specified in Section 27 06 00.

B. A copy of the BICSI RCDD certification as specified in Section 27 07 00 shall be submitted for approval.

C. A copy of all Installer Certifications (who will work on this project) from the manufacturer of the Infrastructure Cabling System shall be submitted for approval. The Certificate shall indicate the level of certification achieved by the installer.

1.5 QUALITY ASSURANCE

A. Install all products in accordance with the manufacturer’s instructions.

B. The manufacturer of the cabling system being installed shall have trained the Contractor’s installers; said installers shall have at least 2 years experience in the installation of Infrastructure Cabling Systems.

C. Manufacturer: The network cabling equipment shall be manufactured by a firm engaged in the manufacture of network cabling systems for a period of at least 10 years.

PART 2 - PRODUCTS

2.1 CATEGORY 6A PLENUM CABLE: NETWORK WIRELESS ACCESS POINT OUTLETS

A. Category 6A Plenum Cables shall meet the following specifications:

1. Horizontal cabling shall be 23 AWG, 4-pair UTP, UL/NEC CMP rated and be independently verified for compliance. Cable performance shall be independently verified by ETL and meet all performance requirements of ANSI/TIA-568-C.2 Category 6A.
2. Cable jacketing shall be Blue and shall be lead-free. Independent verification for flammability compliance shall be to NEC article 800 and NFPA 70; CMP (NFPA 262, UL 910). Horizontal cable shall be CommScope CS44P Series, part # UN874035114/10.

2.2 CATEGORY 6 PLENUM CABLE: DATA, VOICE, BIO-MED, PATIENT MONITORING / PHILIPS, TV

A. Category 6 Plenum Cables shall meet the following specifications:

1. Cable shall be 23 AWG, 4-pair UTP, NEC/NFPA CMP rated and be independently verified for compliance. Cable performance shall be independently verified by ETL and meet the performance requirements per ANSI/TIA-568-C.2 Category 6.
2. Cable performance shall be characterized to 400 MHz. Cable jacketing shall be Blue (except for Philips outlets, where cable jacketing shall be Orange), and shall be lead-free. Independent verification for flammability compliance shall be to NEC article 800 and NFPA 70; CMP (NFPA 262, UL 910). Horizontal cable shall be CommScope CS37P Series, part # UN874043014/10.

2.3 FACEPLATES AND JACKS

A. Faceplates and jacks shall be as follows:

1. Duplex Faceplate, and dual RJ45 empty insert, both Almond color – CommScope 1339118-1, 1116406-1.
2. Dust Cover/Blank Insert, Almond, for faceplate – CommScope 1116407-1.

B. Wireless Access Point (WAP) outlets shall be as follows:

1. Provide two (2) Category 6A cables and jacks at each WAP outlet. Provide 20-foot length service loop in figure-8 shape, managed neatly at outlet, to facilitate future moves of outlet.

2. Category 6A jacks shall be CommScope part # USL10G-DC-BLUE.

3. In air handling (Plenum) spaces, outlets shall be provided/mounted in a steel single-gang deep back-box with stainless steel 2-port faceplate.

4. In non air handling spaces, outlets may be provided in 2-port surface mount plastic box, as manufactured by CommScope, part # 1116698-1.

C. Modular Category 6 Jacks shall be provided for Data/VoIP, Analog Voice, Bio-Medical, and TV outlets, and comply with the following:

1. Modular jacks shall be RoHS compliant, unkeyed, unshielded, 4-pair, RJ-45. Modular jacks shall be color-coded for both T568A and T568B wiring (all jacks to be terminated as

T568B on this project). Each modular jack shall meet all TIA and ISO component performance requirements.

2. Modular jacks shall be compatible with the CommScope NETCONNECT SL Series Modular Jack Termination Tool part number 1725150-1. Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination. Each jack shall incorporate an integral, hinged dust cover. Modular jacks shall be Blue in color for Data, CommScope part # USL600-DC-BLUE.

D. Modular Category 6 Jacks shall be provided for Patient Monitoring / Philips, and comply with the following:

1. Modular jacks shall be RoHS compliant, unkeyed, unshielded, 4-pair, RJ-45. Modular jacks shall be color-coded for both T568A and T568B wiring (all jacks to be terminated as T568B on this project). Each modular jack shall meet all TIA and ISO component performance requirements.
2. Modular jacks shall be compatible with the CommScope NETCONNECT SL Series Modular Jack Termination Tool part number 1725150-1. Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination. Modular jacks shall be Orange for Patient Monitoring / Philips, CommScope part # USL600-DC-ORANGE.

2.4 MODULAR JACK TERMINATION TOOLING

A. Termination of UTP modular jacks at every TO shall be completed using a hand tool which employs a fully repeatable, self centering, non-impact mechanical termination process. This process shall simultaneously cut and terminate all 8 conductors to the modular jack. This hand tool shall be CommScope NETCONNECT part number 1725150-1.

2.5 WORK AREA PATCH CORDS

A. Provide (1) 10-foot Blue Category 6A patch cord with T568B wiring, with every Wireless Network Access Point jack. Patch Cord to be CommScope part # UNC10G.

B. Provide (1) 10-foot Category 6 patch cord with T568B wiring, with every Data, VoIP, Bio-Medical, and Patient Monitoring / Philips jack. Patch Cord to be Blue except for Philips which shall be Orange. CommScope part # UNC6.

C. Provide (1) 10-foot White Category 6 patch cord with every work area Analog Voice Jack Patch Cord, to be CommScope part # UNC6.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate and sequence all work in accordance with the schedule established by the Architect and the lead Prime Contractor.

B. Equipment shall not be installed in dusty and unclean work areas. If equipment is installed and there is still risk of damage to the equipment, this Contractor shall protect and cover all materials and equipment to prevent any damage. All finishes and products shall be protected at all times.

C. Contractor shall provide and install all patch cords at both the work area locations and patch panel locations (reference Section 27 11 00 Distributive Network Rooms) for both data and voice. Typically provide 10 foot long patch cords at the work area.

3.2 INSTALLATION

A. Horizontal cable installation shall be as follows:

1. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
2. Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type.
3. Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document.
4. Where cable splices are allowed, they shall be in accessible locations and housed in an enclosure intended and suitable for the purpose.
5. The cable's minimum bend radius and maximum pulling tension shall not be exceeded.
6. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of four-foot intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
7. Horizontal distribution cables shall be bundled in groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.
8. Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
9. At no point shall cable be installed within six (6) inches of light fixture ballasts or within twelve (47) inches of electrical motors. Reference also Section 27 11 50 Telecommunications Pathways.
10. Cables shall not be attached to ceiling grid or lighting fixture wires.
11. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
12. The cable must not be stripped back any farther than is absolutely necessary. The contractor should follow the manufacturer's specification for the cable being installed. A .5" maximum of exposed (stripped) cable is recommended.
13. The pair twists in the stripped cable should be maintained as close as possible to the point of termination. The twists must be maintained to within .5" from the point of termination.
14. Cables shall be identified by a machine-generated label in accordance with the specification 27 08 00. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
15. Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cables outside diameter (4 X cable O.D.) at any point in the run and at the termination field.
16. Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle.
17. The routing shall be through the ceiling and in the walls wherever possible. All ceiling routing shall be routed in cabling tray through the main corridors as indicated on the floor plan drawings.
18. The floor plan drawings shall be the authoritative source for determining the final drop count for all bids.

19. Cable rollers shall be used when pulling cable. Cable pulleys must be used when pulling cable around bends and corners of wireways. Pulleys shall have a minimum diameter of six inches, so as not to exceed the allowable bend radius of the cable.
20. Contractor shall use basket grips wherever possible, and exercise care while pulling cable so as not to exceed the maximum allowable pulling strength of the cable.
21. Saint Luke's Health System requests that the bidder make every effort to conceal all new cables installed as part of the project. Where impractical or impossible to run cables in ceilings and walls, the bidder should include surface mount raceways or power poles.
22. Pull strings shall be left in each wire routeway.
23. The contractor is responsible to determine the lengths and routing of the copper cable to be installed by examining the floor plan and site drawings and becoming acquainted with the local conditions during the site walk through. Drop lengths should not exceed 90 meters in order to allow the total length of the run, including jumpers at both ends to fall within the 100 meter standard for Categories 6A, 6 and 5e installations.
24. Managing cable lengths is essential to overall system integrity. The cable shall be routed as shown on the drawings. The contractor shall make every effort to conceal all new cables installed as part of the project. Where impractical or impossible to run cables in conduit, ceilings and walls, the contractor shall include surface mount raceways or power poles.

B. Categories 6A, 6 and 5e work station outlet installations shall comply with the following:

1. Jacks shall be terminated to T568B wiring pin-out pattern.
2. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius.
3. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. 12" of UTP slack shall be stored in in-wall boxes, modular furniture raceway, or insulated walls.
4. 3-feet of additional slack shall be neatly coiled and stored in the ceiling above each drop location.
5. Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-C documents, manufacturer's recommendations and/or best industry practices.
6. Pair untwist at the termination shall not exceed one-half an inch.
7. Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.
8. The cable jacket shall be maintained as close as possible to the termination point.

END OF SECTION

SECTION 27 41 33

MASTER ANTENNA TELEVISION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes the following:

1. Master antenna television system using Time Warner television service as the signal source.
2. Broadband coaxial cabling, and Category 6 cabling, for distributing television signal to interface points (outlets).

1.3 DEFINITIONS

A. Agile Receiver: A broadband receiver that can be tuned to any desired channel.

B. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.

C. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, it is spread out over a wider band. The carrier frequency is the center frequency on any television channel.

D. CCTV: Closed-circuit television.

E. CEA: Consumer Electronics Association.

F. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms. dBmV = 20 log $10(V_1/V_2)$ where V_1 is the measurement of voltage at a point having identical impedance to V_2 (0.001 V across 75 ohms).

G. Headend: The control center of the master antenna television system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "Central Retransmission Facility."

H. RF: Radio frequency.

I. User Interface: End point of Contractor's responsibility for Work of this Section. User interfaces are the faceplates with adapters to which the end user may connect coaxial cabling.

1.4 SYSTEM DESCRIPTION

A. System shall consist of coaxial cable distribution system via RG6 cables, and IPTV via Category 6 Data cables, from outlets to new IT Room.

B. Headend equipment shall remain as existing. Any additional amplification, line equalizers, and/or annenuators if required will be provided by Time Warner.

C. Cable distribution system consisting of coaxial cables, connectors on cables at both ends, and user interfaces with adapters.

D. ½" hardline backbone trunk cables, where required, shall be provided from equipment head-end location to applicable Network Room(s) by TV service provider.

1.5 PERFORMANCE REQUIREMENTS

A. Minimum acceptable distribution system performance at all user-interface points shall be as follows:

1. RF Video Carrier Level: Between 3 and 12 dBmV.
2. Relative Video Carrier Level: Within 3 dB to adjacent channel.
3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60-minute period.
4. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24-hour period.
5. Channel Frequency Response: Across any 6-MHz channel in 54- to 220-MHz frequency range, referenced to video carrier, signal amplitude shall be plus or minus 1 dB, maximum.
6. Carrier-to-Noise Ratio: 45 dB or more.
7. RF Visual Signal-to-Noise Ratio: 43 dB or more.
8. Cross Modulation: Less than minus 50 dB.
9. Carrier-to-Echo Ratio: More than 40 dB.
10. Composite Triple Beat: Less than minus 53 dB.
11. Second Order Beat: Less than minus 60 dB.
12. Terminal Isolation from Television to Television: 25 dB, minimum.
13. Terminal Isolation between Television and FM: 35 dB, minimum.
14. Hum Modulation: 2 percent, maximum.
15. RF FM Carrier Level: 13 to 17 dB below video carrier level.
16. FM Frequency Response: More than the 88- to 108-MHz frequency range, signal amplitude is plus or minus 0.75 dB, maximum.
17. FM Carrier-to-Noise Ratio: More than 24 dB.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for television equipment.

1. Include plans, elevations, sections, details, and attachments to other work.
2. For coaxial cable, include the following installation data for each type used:

    a. Nominal OD.
    b. Minimum bending radius.
    c. Maximum pulling tension.

3. Functional Block Diagram: Show single-line interconnections between components for distribution system to user-interface points. Show cable types and sizes.
4. Wiring Diagrams: Power, signal, and control wiring; and grounding.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add testing record of each piece of adjustable equipment, listing name of person testing, date of test, and description of as-left set points.

D. Source quality-control test reports on coaxial cable sweep tests.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For headend and distribution system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.
2. Include dimensioned plan and elevation views of components and enclosures. Show access and workspace requirements.

1.7 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 NECA 1.

C. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: System components shall be equipped and rated for the environments where installed.

1.9 COORDINATION

A. Coordinate size and location of raceway system.

B. Coordinate Work of this Section with requirements of cable television service provider.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SYSTEMS REQUIREMENTS

A. Components: Modular plug-in, heavy-duty, industrial- or commercial-grade units.

B. Equipment: Silicon-based, solid-state, integrated circuit devices.

C. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

2.3 DISTRIBUTION COMPONENTS

A. User-Interface Device: Flush, female-type outlets, designed to mimic power duplex outlet, for mounting in standard outlet box, with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semirecessed so its protrusion is flush with the plane of device plate. Feedthrough-type cable connection shall not be used.

1. Outlet Adapters:

a. Female, Type F, as manufactured by CommScope / TE Connectivity.
b. Category 6 data jack, as manufactured by CommScope / TE Connectivity.

2. Attenuation: Less than 0.1 dB.
3. Voltage Standing-Wave Ratio: Less than 1.15 to 1.
4. Wall Plates: Match materials and finish of Data / Voice faceplates and outlets in same space. Manufactured by CommScope / TE Connectivity, 2-port, finish and color to match Data / Voice wall plates on the project.

2.4 CABLES

A. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband MATV applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB minimum from 7 to 806 MHz, and shall be listed to comply with NFPA 70, Articles 810 and 820.

B. RG6/U, Plenum-Rated Indoor Distribution Cable: No. 18 AWG, solid, bare copper conductor; foam fluorinated ethylene propylene (FFEP) insulation. Double shielded with 100 percent aluminum-foil shield, 90 percent aluminum braid. Copolymer jacket. NFPA 70, Type CATVP / CMP, RoHS compliant. Belden # 633938 or equivalent by General Cable.

C. IPTV: Provide one (1) Category 6 Blue Data cable at every TV outlet, in same outlet faceplate as RG6/U cable termination. Refer to Specification 27 15 00 Horizontal Cabling for additional requirements of this cable.

D. 1/2" Hardline Plenum-Rated Indoor Trunk Cable: by TV service provider when required.

2.5 CABLE CONNECTORS

A. RG6 Compression Type F, 75 ohms by Belden / Thomas & Betts or Blonder Tongue. Use compression tool designed for connector utilized.

B. Terminate Category 6 Data cable at each TV outlet via Category 6 data jack at outlet plate, and on Category 6 data patch panel in Network Room serving the area.

C. 1/2" hardline 2-piece type by Corning Gilbert, # G2-500-CH-PH3 or equivalent by Belden / Thomas & Betts.

D. Leave 10’ service loop at both ends of each cable.

2.6 SOURCE QUALITY CONTROL

A. Cable products shall be sweep tested at the factory before shipping at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for coaxial cable installation. Check raceways, cables, trays, and other elements for compliance with accessibility for installation and maintenance, and other conditions affecting installation.

B. Examine roughing-in for antenna to verify actual locations of cable connections before antenna installation.

C. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where television equipment is to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL WIRING

A. Wiring Method: Install cables in raceways except in accessible indoor ceiling spaces and as otherwise indicated. Conceal raceways and wiring except in unfinished spaces.

3.3 COAXIAL CABLE INSTALLATION

A. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.

B. Cable may not be installed in same raceway with power cable.

C. Coaxial cable shall not be spliced except on plywood backboards in wire closets, or in cabinets designated for the purpose.

D. Outdoor connections shall be installed in enclosures meeting NEMA 250, Type 4X. Connectors shall be corrosion resistant with properly designed O-rings to keep out moisture.

E. Do not use water-based cable pulling lubricants with PVC-jacketed cable.

F. Do not exceed manufacturer's recommended minimum bending radiuses

G. Pulling Cable: Do not exceed manufacturer's recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

H. Exposed Cable: Install parallel to building lines, follow surface contours, and support cable according to manufacturer's written instructions. Do not run adjacent and parallel to power or data cables.

I. Cable Support: Install supports at intervals recommended in writing by cable manufacturer. Install supports within 6 inches (150 mm) of connector so no weight of cable is carried by connector. Use no staples or wire ties, pull tie-wrap snug, and do not over tighten.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Basic Electrical Materials and Methods."

3.5 FIELD QUALITY CONTROL

A. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

B. Test coax cables to ensure continuity and attenuation levels do not exceed cable manufacturers’ specifications.

C. Repair or replace at no additional cost to Owner, any cables and connectors as required if any deficiencies discovered during cable tests or during Time Warner’s system testing.

END OF SECTION

SECTION 27 51 16
OVERHEAD PAGING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. Section Includes:

1. Loudspeakers.
2. Conductors and cables.
3. Raceways.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:Wiring Diagrams: For power, signal, and control wiring.
2. Single-line diagram showing interconnection of components.
3. Cabling diagram showing cable routing.

C. Qualification Data: For qualified Installer.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:

1. Connect system into existing hospital overhead paging system and match current functionality. Visit site prior to bid as required.
2. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

2.2 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Utilize existing Biamp AudiaFlex Digital Audio Platform. Provide additional transformers as required to support new speakers.

2.3 LOUDSPEAKERS

A. Ceiling Speaker Assembly:

1. Sensitivity: 93 dB at 1 meter, with 1-watt input.
2. Frequency Response: 65 to 17,000 Hz.
3. Size: 8 inch, 5-oz. ceramic magnet.
4. Matching Transformer: 25V/70V with taps at 0.3125, 0.625, 1, 2, and 5 watts.
5. Baffle: White, 22-guage cold-rolled steel.
6. Baffle Size: 23.75”W x 23.75”L x 3.375”D
7. Weight: 6 lbs. 1 oz.
8. Rauland # BAFKIT2X2LVC

2.4 CONDUCTORS AND CABLES

A. Jacketed, Plenum rated, shielded, twisted pair, untinned solid copper. Size conductors according to speaker manufacturer’s guidelines for appropriate signal attenuation.

2.5 RACEWAYS

A. Route cables in separate pathway from cable tray, provide j-hooks or bridle rings on maximum 5’ spans and minimum 12” above ceilings for neat and professional installation.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible. Do not exceed manufacturer’s guidelines for maximum pulling tensions and minimum bend radius.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
4. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 12 inches above ceiling by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.3 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors not smaller than No. 18 AWG.

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative as needed to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing overhead paging system and after electrical circuitry has been energized, test for compliance with requirements. Verify proper routing and volume levels and that system is free of noise and distortion.

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

D. Overhead paging system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.6 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative as needed to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of final acceptance by Owner, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION

SECTION 27 52 23

NURSE CALL SYSTEMS

PART 1 - GENERAL

1.1 OVERVIEW

A. The Nurse Call system for this project will be procured directly by Saint Luke's Hospital. The Electrical Contractor shall provide all rough-ins, installation of the equipment, wiring, raceways and associated equipment. This specification section includes the nurse call system specifications for the entire system as a reference for the Contractor.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This section specifies the furnishing, installing, and testing of a complete networked Audio-Visual Nurse Call system. The system outlined here is to include all necessary devices that provide the functions listed in this specification.

1. Provide a raceway system and backboxes. Minimum size of conduit shall be ¾ inch, unless noted otherwise. Extend ¾ inch conduit up to above corridor accessible ceiling. Where devices are indicated to be installed in plaster ceilings, provide conduit to accessible ceiling space. All raceways shall comply with all preceding specification requirements relative to raceways and fittings.
2. Cables supported and tied within cable tray as required, to obtain an installation neat in appearance. Cables shall be tagged with identification labels.
3. Furnish 120 volt circuit to power each of the equipment cabinets as indicated on the drawings.
4. Furnish and install wiring per manufacturer's representative's shop drawing submittal.
5. Maintain record drawing of any wiring installation that deviates from shop drawing submittal.

1.4 REFERENCES

A. Underwriter's Laboratories UL-1069 current release

B. NFPA – National Fire Protection Association

C. NEC – National Electrical Code - NFPA 70 and 99

D. ADA – Americans with Disabilities Act

E. EIA – Electronic Industry Association

F. NEMA – National Electrical Manufacturers Association – Installation Standards

G. U.S. Dept. of Labor / Occupational Safety and Health Administration

H. State Hospital Code / Joint Commission of Hospitals – Nurse Call Requirements

I. Canadian Standards Association

1.5 QUALITY ASSURANCE

A. Qualifications:

1. The system shall be the product of a manufacturer or an agency experienced in such work.
2. All items shall be of the latest technology; no discontinued models or products are acceptable.
3. Installer Qualifications: Manufacturer's Authorized Representative who is trained and approved for installation of units required for this project, and who has applicable state licences.
4. The Manufacturer or the Authorized Representative shall provide proof that within 60 miles of the project they maintain:

    a. A full complement of parts to support the installation.
    b. Offer service by fully trained and qualified technicians during normal working hours.
    c. Will supply parts and service without delay and at a reasonable cost.

B. Regulatory Requirements:

1. Electrical Components, Devices, and Accessories: Listed and labeled according to UL1069 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NEC as applicable to construction and installation of system components and wiring.
3. Conform to NFPA 70.
4. Conform to HIPAA regulations relating to paging and public address systems.
5. Systems may be subject to inspection and require accreditation from agencies such as OSHPOD and Joint Commission if mandated by the owner. Suppliers of all systems must include all documentation and staff to support the owner during these inspections and certifications.

1.6 SYSTEM DESCRIPTION

A. System hardware shall consist of a nurse/patient communications network comprised of nurse consoles, control stations, dome lights, entertainment cords, call cords, pull cord stations, emergency push button stations, wiring and other options such as bed side-rail interfaces, pocket page interfaces, computer interfaces, wireless/telephone network interfaces, X-bus adapter module and infrared locating system interface as shown on drawings. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed to provide a complete and operating nurse/patient communications network.

1.7 SUBMITTALS

A. Any supplying contractor proposing equipment which is not the base standard for this specification must provide full submittals at the time of bid. This option shall be exercised at the discretion of the Owner/specifying authority.

B. Prior to commencement of work, the supplying contractor shall submit six (6) complete submittal sets. Each set shall consist of the following:

1. Product Data: For each type of product indicated.
2. Shop Drawings: Detail the system including the following:

    a. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
    b. Wiring Diagrams: Power, signal, and control wiring.
    c. Station Installation Details: For built-in equipment; dimensioned and to scale.
    d. Equipment Cabinet Drawings: Dimensioned and to scale.

3. Coordination Drawings: Detail system components that fit, match, and line up with provisions made for equipment specified in other Sections or in separate contracts:

    a. Head-wall units.
    b. Power columns.

4. Manufacturer Certificates: Signed by manufacturers certifying that nurse call equipment complies with requirements.
5. Manufacturer’s Warranty Statement.

C. Close-Out Documentation: At project completion, and prior to final payment to supplying contractor, supplying contractor shall provide:

1. Field Tests Reports and Observations: Include record of final adjustments certified by Installer.
2. Operation and Maintenance Data: For nurse call equipment to include installation, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

    a. Operating instructions.
    b. Troubleshooting guide.
    c. Wiring diagrams and terminal identification.
    d. Equipment parts list.
    e. Product data for types and sizes of wires and cables used.

1.8 COORDINATION

A. It is the responsibility of the contractor to coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified. The Owner will not be liable for any additional costs due to missed dates or poor coordination of the supplying contractor with other trades.

B. Coordinate patient control units (pillow speakers and feature bed side rails) to provide remote control of devices, such as televisions and lighting, which are not part of the nurse call system.

C. Coordinate wiring paths and maintenance access at locations listed below. Coordinate trim features and finishes at these locations to present a unified design appearance.

1. Patient head-wall units
2. Patient foot-walls
3. Bathrooms
4. Nursing stations
5. Staff areas

1.9 WARRANTY

A. The installing manufacturer's representative shall guarantee all labor, parts, and installation for a period of 1 year from substantial completion or first beneficial use of the system.

B. Provide manufacturer five (5) year warranty for the nurse call / code blue system.

C. Provide manufacturer two (2) year warranty for accessories including call cords and pillow speakers.

PART 2 - PRODUCTS AND FUNCTIONAL REQUIREMENTS

2.1 MANUFACTURERS

A. Manufacturers: The products specified shall be the standard models of a single reputable manufacturer. Subject to compliance with requirements, provide products by the following:

1. Jeron Electronic Systems, Inc.

2.2 SYSTEM REQUIREMENTS

A. Provide a complete turn-key Nurse Call Communications system operating as a single integrated solution. Match components and interconnections for optimum performance of all specified functions.

B. All Nurse Call Network devices shall be UL-1069 listed including all Gateways, Nurse Consoles, Staff Terminals, Data Switches, Patient Stations, Staff Stations, Room Controllers, Dome Lights, Zone Lights, Peripheral Stations, Pillow Speakers, and Call Cords.

C. The system shall be a life safety grade design with continuous 24/7 availability without the need for routine rebooting to install updates such as operating system or virus definition updates. As such, the core life safety UL1069 components of the system shall not utilize a Personal Computer, embedded Personal Computer, or commercial operating system vulnerable to software virus attacks. The system shall remain fully operational during any programming with no loss of active calls, active communications, or the need to reboot the system.

D. System shall be network-based with a distributed architecture allowing remote survivability should the network connection be lost. All inter-Gateway communications shall utilize Voice over IP and Ethernet technology.

E. To interconnect all nurse call Gateways, the system shall support either a dedicated Layer 2 subnet (private nurse call network) or a Layer 3 network with multiple subnets to leverage the facility's existing LAN infrastructure. Nurse call systems which do not support both Layer 2 and Layer 3 networking architectures are unacceptable.

F. For superior intelligibility, all audio communication among nurse call devices must be digital full duplex audio, including audio communication to/from Nurse Consoles, Staff Terminals, and to each individual room for Staff, Duty, and Patient Stations. System shall provide a minimum of eight (8) simultaneous audio connections for each group of up to thirty one (31) Patient and Staff areas to provide fast, instantaneous communications without waiting for an available audio path. The system's simultaneous audio path capacity shall be included in the base system and not require any additional licensing or costs.

G. The system shall be capable of supporting at least 1,000 unique call priority, rounding, reminder, and workflow events, each with a unique call tone/voice prompt. The system shall include standard call tones/voice prompts with the ability to import WAV files to customize the call tones/voice prompts to each facility's requirements. Throughout the entire system, all Nurse Consoles, Staff Terminals, and Duty Stations with intercom, will annunciate the same call tones/voice prompts for each respective call priority.

H. The system shall be capable of supporting at least 1,000 Nurse Consoles, and any combination of at least 50,000 Patient, Staff, Duty, and Peripheral Stations.

I. All wiring between Gateways, Nurse Consoles, Staff Terminals, Data Switches, Room Controllers, Zone Lights, Staff Stations, Duty Stations, and Patient Stations shall utilize standard CMP Plenum-rated CAT 6 cabling and terminations; additional non-category cabling or shielded audio cable shall not be required to each individual room or between any of these components.

J. System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to ESD (electrostatic discharges) of up to 25,000 volts in an environment with a relative humidity of 20 percent or less. Patient Stations must be rated to ESD of 100,000 volts in an environment with a relative humidity of 20 percent or less.

K. Nurse Call Network provides continuous supervision of all devices on the system including: Gateways, Nurse Consoles, Staff Terminals, Data Switches, Room Controllers, Lights, Zone Lights, Staff Stations, Duty Stations, Patient Stations, and Peripheral Stations. Any supervision failure will alarm at predetermined Nurse Console(s) (indicating the room number and type of failure) and to a technician's pocket pager through the pocket page interface option.

L. All end-devices, including Nurse Consoles, Staff Terminals, Room Controllers, Zone Lights, Staff Stations, Duty Stations, Patient Stations, and Peripheral Stations:

1. May be hot-swapped without needing to power down the local system.
2. Are continuously supervised for data and power with central notification of any supervision error.
3. All employ plug-in terminations for simple service or replacement.
4. Are easily cleaned and impervious to common hospital cleaning agents.

M. Nurse call platform supports both nurse call and clinic modes of operation including clinic rooming of patients and sequencing of clinicians.

N. All system programming and firmware updates use a flexible GUI application for simple on-site or remote administration of all system attributes. All system programming and updates are done through a direct, facility LAN, or remote VPN connection.

2.3 EQUIPMENT AND FUNCTIONALITY SPECIFICATIONS

A. Ethernet Data Switch
Each Ethernet Data Switch shall provide the following:

1. Interconnection of any combination of up to 8 Nurse Call Gateways.
2. An uplink port to interconnect multiple data switches as part of complete distributed Nurse Call Network.
3. Optional fiber interconnect supporting a multi-mode fiber connection between Data Switches of up to two kilometers.
4. Mounts in standard 19 inch data rails, 19 inch equipment racks, or in a terminal cabinet.

B. Nurse Call Gateway
Each Nurse Call Gateway shall provide the following:

1. Interconnecting local Room Controllers, Zone Lights, Patient Stations, Staff Stations, Duty Station, Nurse Consoles, and Staff Terminals for all power, communications, and call routing.
2. Non-blocking duplex digital audio communications between Nurse Consoles, Staff Terminals and to each individual room for Staff, Duty, and Patient Stations providing a minimum of eight (8) simultaneous speech paths from each Gateway.
3. Continuous supervision of all connected components.
4. Mounting in standard 19 inch data rails, 19 inch equipment racks, or in a terminal cabinet.

C. Power Supply

1. Power and integrated battery backup for associated Ethernet Data Switch, Nurse Call Gateway and all local components including: Nurse Consoles, Staff Terminals, Room Controllers, Zone Lights, Patient Stations, Staff Stations, Duty Stations, and Peripheral Stations.
2. Mounts in standard 19 inch data rails, 19 inch equipment racks, or in a terminal cabinet.

D. Touchscreen VoIP Nurse Consoles
Each Nurse Console shall provide the following:

1. Utilize VoIP over an Ethernet LAN connection to communicate with the associated Nurse Call Gateway(s) and Ethernet Data Switch(es).
2. Full duplex digital audio communications with the choice of handset communications for semi-private conversations or communications through the built-in speaker and separate microphone.
3. Optional support for integration to a Bluetooth headset allowing users to be alerted to active calls and to answer calls over a Bluetooth headset while within Bluetooth range of the Nurse Console.
4. 5.7 inch color backlit touchscreen with:

    a. 320 x 240 pixel resolution.
    b. 12 or 24 hour time display synchronized to facilities network time with automatic updates for daylight saving time changes.

5. Touchscreen menu-driven operation for all functions plus four (4) tactile buttons for the commonly used features:

    a. Push-to-Talk button: controls talk/listen direction in open voice communications.
    b. Tone Silence button: mutes incoming call audible alert tone. Any new call annunciating at the Nurse Console restarts call alert tones. Ability to disable tone silence functionality during system configuration.
    c. Quit button: backs users out of current operation and back to previous menu screen.
    d. Home button: cancels all menu driven operations and returns to the home screen.

6. Call Annunciation:

    a. Displays a minimum of four (4) outstanding patient and/or staff calls with individual elapsed timer per call and automatic sequencing of calls by priority and/or time of call so that oldest or highest priority call is always displayed first.
    b. Call tone annunciation for the highest priority call displayed.
    c. Four (4) call status level indicators (ROUTINE, URGENT, EMERGENCY, CODE) to quickly identify highest priority call level.
    d. Programmable timer for unanswered calls with automatic upgrade, and display of outstanding calls.
    e. Ability to respond to calls out of sequence by touching active call on the screen.
    f. Four (4) modes of viewing outstanding calls and clinic room status: two (2) line “Zoom In” view shows the detail of up to two (2) outstanding calls clearly visible from up to ten (10) feet away, four (4) line “Standard” view shows the detail of up to four (4) outstanding calls, “Zoom Out” view showing up to thirty (30) outstanding calls, and “Clinic” view showing up to thirty (30) clinic rooms’ status emulating the dome light indication outside of each clinic room.

7. Communications:

    a. Hands-free full duplex communication when communicating with Patient, Staff, or Duty stations. Stations can converse with Nurse Consoles and Terminals hands-free and from anywhere within the room where the intercom station is located.
    b. Semi-private audio communication over integrated handset.
    c. Open voice audio communication over integrated speaker and microphone. During communications with an intercom station, lifting the handset on Nurse Console disconnects speaker and microphone and transfers conversation to the handset.
    d. Ability to direct dial to establish audio communications with any Patient Station, Staff Station, Duty Station, Nurse Console, or Staff Terminal located anywhere on the Nurse Call Network.
    e. Individual talk/listen volume control for each Patient Station, Staff Station, and Duty Station.
    f. Ability to monitor one or several user-selected rooms sequentially.

8. Audio Paging:

    a. Programmable page groups with visual display of group designator while paging.
    b. Ability to include any number of patient and staff intercom stations as part of a predefined group page.

9. Service Requirements:

a. Upon answering a call, the ability to set a Green, Orange, Amber, or Stat level Service Requirement to notify the appropriate caregiver(s) assigned to that patient.
b. Ability to display beds with outstanding Green, Orange, Amber, or Stat Service Requirements. Touching displayed room establishes communications with that room.
c. Programmable timers for unanswered Service Requirements with automatic upgrade and call back.

10. Staff Registration:

a. Provisions for staff registration using Staff Registration Stations or Real Time Locating System (RTLS) integration.
b. Ability to display locations of all registered Green, Orange, and/or Amber level caregivers. Touching displayed room establishes communications with that room.
c. Upon registering into the room, any outstanding Service Requirements matching the caregiver's level or any outstanding patient calls, configured for remote cancel, will be automatically cleared.

11. Rounding and Reminders:

a. While in communication with a Patient Station or by dialing a Patient Station, have the ability to set a repeating Rounding or a one-time Reminder for a specific room and bed. The Roundings and Reminders can be set for 15, 30, 60, and 120 minute time periods and for green, orange, or amber level staff. Multiple Rounding and Reminders (one of each color level) can be active concurrently for the same room and bed.
b. Ability to review active Rounding and Reminders by level, active and oldest, and by elapsed time. Selecting a Rounding or Reminder will instantly connect audio to the Patient Station and bed.
c. A Rounding can be reset by pressing the cancel button on the Patient Station, the corresponding active Rounding button on a Procedure Station, or by registering into the patient room with a staff level (green, orange, or amber) that matches the active Rounding. When a Rounding is reset the time period for the Rounding starts over. A Rounding can be canceled from a Nurse Console.
d. A Reminder can be cleared by pressing the cancel button on the Patient Station, the corresponding active Reminder button on a Procedure Station, or by registering into the patient room with a staff level (green, orange, or amber) that matches the active Reminder. A Reminder can also be canceled from a Nurse Console.

12. Pocket Page Messaging

a. Ability to send pocket page messages to on-duty staff within a Nurse Console's coverage area.
b. Pocket page message can include a preset "tag" message or a free-form message using the touchscreen keyboard on the Nurse Console.

13. Room Swing and Day/Night Transfer:

a. Ability for up to ten (10) pre-designated rooms to be temporarily rerouted ("swung") to a Nurse Console or Staff/Duty Terminal in an adjoining area. Once a room has been swung, all calls originating from that room will only annunciate at the other Console/Terminal. The Console/Terminal that swung the room shall be capable of returning the swung room to annunciate at the original Console/Terminal.

b. Ability of all rooms reporting to a Nurse Console or Staff/Duty Terminal to be rerouted (“day/night transferred”) to any other Console/Terminal in an adjoining area. Normal operation is restored to the original Console/Terminal when a staff member “releases” the day/night transfer.

14. Clinic Operation:

    a. Ability to remotely room a patient by touching the desired room on the display in the “clinic” view.
    b. Ability to remotely clear a roomed patient by touching the desired room on the display in the “clinic” view.

15. The ability to service exchange Nurse Console “hot” without removing system power or powering down the local Gateway.
16. Standard desktop mounting (desktop stand included) or optional wall-mounting (with or without handset).

E. Touchscreen VoIP Staff Terminals
Each Staff Terminal shall provide the following:

1. Utilize VoIP over an Ethernet LAN connection to communicate with the associated Nurse Call Gateway(s) and Data Switch(es).
2. Full duplex digital audio communications through the built-in speaker and separate microphone with the choice of hands-free or push-to-talk control of the audio
3. 5.7 inch color backlit touchscreen with:

    a. 320 x 240 pixel resolution.
    b. 12 or 24 hour time display synchronized to facilities network time with automatic updates for daylight saving time changes.
    c. Automatic timeout to a screen saver mode showing current system time in hours, minutes, and seconds.
    d. Optional password protection requiring a code to unlock the screen saver mode.

4. Touchscreen menu-driven operation for all functions plus four (4) tactile buttons for the commonly used features:

    a. Push-to-Talk button: controls talk/listen direction in open voice communications.
    b. Tone Silence button: mutes incoming call audible alert tone. Any new call annunciating at the Staff Terminal restarts call alert tones. Ability to disable tone silence functionality during system configuration.
    c. Quit button: backs users out of current operation and back to previous menu screen.
    d. Home button: cancels all menu driven operations and returns to the home screen.

5. To eliminate the requirement for a Staff Terminal for each patient bed or in each patient room, the system will support a single Staff Terminal for up to ten (10) beds in a common room or a single Staff Terminal for up to four (4) separate patient rooms with up to four beds in each room.
6. Support for both Staff Terminal and Nurse Console operation in the same station without needing to change software or configuration:

    a. In the unlocked mode, without staff signed in, the Terminal supports up to six (6) customizable screens and over sixty (60) customized buttons for:

1) One-touch call placement of any of the call priorities available on the system. Calls can be cleared by pressing the button again or pressing the Cancel button on the Terminal. Code calls can include a count up timer with local reset timer and clear timer capability.
2) One-touch setting and clearing of Rounding & Reminders. Each button sets and clears a Rounding or Reminder for a specific time period (15, 30, 60, or 120 minutes) and a specific staff level (green, orange, or amber).
3) One-touch intercom to any Nurse Console, Staff/Duty Terminal or Staff Terminal anywhere throughout the entire Nurse Call Network
4) Workflow event setting and clearing. The workflow buttons can be independent with toggle on/off operation or can be part of a sequence of up to four workflow events where pressing the subsequent event button clears the previous event button.
5) Pocket Page Messaging to send pocket page messages to on-duty staff within a Staff Terminal coverage area. The pocket page message can include a preset “tag” message or a free-form message using the touchscreen keyboard on the Staff Terminal.

b. To prevent unauthorized access to sensitive features and patient information, the Staff Terminal is locked and prevents access to Nurse Console features. After logging into the Staff Terminal, staff can access the Nurse Console mode of operation which supports:

1) Log out with a single button press to return the Staff Terminal to the locked mode of operation.
2) Call Annunciation:

a) Displays a minimum of four (4) outstanding patient and/or staff calls with individual elapsed timer per call and automatic sequencing of calls by priority and/or time of call so that oldest or highest priority call is always displayed first.
b) Call tone annunciation for the highest priority call displayed.
c) Four (4) call status level indicators (ROUTINE, URGENT, EMERGENCY, CODE) to quickly identify highest priority call level.
d) Programmable timer for unanswered calls with automatic upgrade, and display of outstanding calls.
e) Ability to respond to calls out of sequence by touching active call on the screen.
f) Three (3) modes of viewing outstanding calls: two (2) line “Zoom In” view shows the detail of up to two (2) outstanding calls clearly visible from up to ten feet away, four (4) line “Standard” view shows the detail of up to four (4) outstanding calls, and “Zoom Out” view shows up to thirty (30) outstanding calls.

3) Service Requirements:

a) Upon answering a call, the ability to set a Green, Orange, Amber, or Stat level Service Requirement to notify the appropriate caregiver(s) assigned to that patient.
b) Ability to display beds with outstanding Green, Orange, Amber, or Stat Service Requirements. Touching displayed room establishes communications with that room.
c) Programmable timers for unanswered Service Requirements with automatic upgrade and call back.

4) Staff Registration:

a) Provisions for staff registration using Staff Registration Stations or Real Time Locating System (RTLS) integration.
b) Ability to display locations of all registered Green, Orange, and/or Amber level caregivers. Touching displayed room establishes communications with that room.
c) Upon registering into the room, any outstanding Service Requirements matching the caregiver's level or any outstanding patient calls, configured for remote cancel, will be automatically cleared.

5) Rounding and Reminders:

a) While in communication with a Patient Station, the ability to set a repeating Rounding or a one-time Reminder for a specific room and bed. The Roundings and Reminders can be set for 15, 30, 60, and 120 minute time periods and for green, orange, or amber level staff. Multiple Rounding and Reminders can be active at the same time for the same room and bed.
b) Ability to review active Rounding and Reminders by level, active and expired, and by remaining time. Selecting a Rounding or Reminder will instantly connect audio to the Patient Station and bed.
c) A Rounding can be reset by pressing the cancel button on the Patient Station, the corresponding active Rounding button on a Procedure Station, or by registering into the patient room with a staff level (green, orange, or amber) that matches the active Rounding. When a Rounding is reset the time period for the Rounding starts over. A Rounding can be canceled from a Nurse Console.
d) A Reminder can be cleared by pressing the cancel button on the Patient Station, the corresponding active Reminder button on a Procedure Station, or by registering into the patient room with a staff level (green, orange, or amber) that matches the active Reminder. A Rounding can also be canceled from a Nurse Console.

6) Communications:

a) Hands-free full duplex communication when communicating with Patient, Staff, or Duty stations. Stations can converse with the Staff Terminal hands-free and from anywhere within the room where the intercom station is located.
b) Open voice audio communication over integrated speaker and microphone.
c) Ability to direct dial to establish audio communications with any Patient Station, Staff Station, Duty Station, Nurse Console, or Staff Terminal located anywhere on the Nurse Call Network.
d) Individual talk/listen volume control for each Patient Station, Staff Station, and Duty Station.

7. The ability to service exchange Staff Terminal "hot" without removing system power or powering down the local Gateway.

8. Standard wall-mount and optional desk-stand mounting.

F. Touchscreen VoIP Staff/Duty Terminals
Each Staff/Duty Terminal shall provide the following:

1. Utilize VoIP over an Ethernet LAN connection to communicate with the associated Nurse Call Gateway(s) and Data Switch(es).
2. Full duplex digital audio communications through the built-in speaker and separate microphone
3. 5.7 inch color backlit touchscreen with:

    a. 320 x 240 pixel resolution.
    b. 12 or 24 hour time display synchronized to facilities network time with automatic updates for daylight saving time changes.

4. Touchscreen menu-driven operation for all functions plus four (4) tactile buttons for the commonly used features:

    a. Push-to-Talk button: answers displayed call and controls talk/listen direction in open voice communications.
    b. Tone Silence button: mutes incoming call audible alert tone. Any new call annunciating at the Staff/Duty Terminal restarts call alert tones. Ability to disable tone silence functionality during system configuration.
    c. Quit button: backs users out of current operation and back to previous menu screen.
    d. Home button: cancels all menu driven operations and returns to the home screen.

5. Call Annunciation:

    a. Four (4) large color coded status level indicators (ROUTINE, URGENT, EMERGENCY, CODE) to identify active calls within the terminals coverage area
    b. A display of the highest priority outstanding patient and/or staff calls with the ability to scroll to additional waiting calls.
    c. Call tone annunciation for the highest priority call displayed.
    d. Programmable timer for unanswered calls with automatic upgrade, and display of outstanding calls.
    e. Ability to respond to calls out of sequence by scrolling to the active call and then pressing the Push-To-Talk button to answer.

6. Communications:

    a. Hands-free full duplex communication when communicating with Patient, Staff, or Duty stations. Stations can converse with Nurse Consoles and Terminals hands-free and from anywhere within the room where the intercom station is located.
    b. Ability to direct dial to establish audio communications with any Patient Station, Staff Station, Duty Station, Nurse Console or Terminal located anywhere on the Nurse Call Network.
    c. Individual talk/listen volume control for each Patient Station, Staff Station, and Duty Station.
    d. Ability to monitor one or several user-selected rooms sequentially.

7. Audio Paging:

    a. Programmable page groups with visual display of group designator while paging.
    b. Ability to include any number of patient and staff intercom stations as part of a predefined group page.

8. Service Requirements:

    a. Upon answering a call, the ability to set a Green, Orange, Amber, or Stat level Service Requirement to notify the appropriate caregiver(s) assigned to that patient.
    b. Ability to display beds with outstanding Green, Orange, Amber, or Stat Service Requirements. Touching displayed room establishes communications with that room.
    c. Programmable timers for unanswered Service Requirements with automatic upgrade and call back.

9. Staff Registration:

    a. Provisions for staff registration using Staff Registration Stations or Real Time Locating System (RTLS) integration.
    b. Ability to display locations of all registered Green, Orange, and/or Amber level caregivers. Touching displayed room establishes communications with that room.
    c. Upon registering into the room, any outstanding Service Requirements matching the caregiver's level or any outstanding patient calls, configured for remote cancel, will be automatically cleared.

10. Rounding and Reminders:

    a. While in communication with a Patient Station or by dialing a Patient Station, have the ability to set a repeating Rounding or a one-time Reminder for a specific room and bed. The Roundings and Reminders can be set for 15, 30, 60, and 120 minute time periods and for green, orange, or amber level staff. Multiple Rounding and Reminders (one of each color level) can be active concurrently for the same room and bed.
    b. Ability to review active Rounding and Reminders by level, active and oldest, and by elapsed time. Selecting a Rounding or Reminder will instantly connect audio to the Patient Station and bed.
    c. A Rounding can be reset by pressing the cancel button on the Patient Station, the corresponding active Rounding button on a Procedure Station, or by registering into the patient room with a staff level (green, orange, or amber) that matches the active Rounding. When a Rounding is reset the time period for the Rounding starts over. A Rounding can be canceled from a Nurse Console.
    d. A Reminder can be cleared by pressing the cancel button on the Patient Station, the corresponding active Reminder button on a Procedure Station, or by registering into the patient room with a staff level (green, orange, or amber) that matches the active Reminder. A Reminder can also be canceled from a Nurse Console.

11. Clinic Operation:

    a. Ability to "room" a patient and direct clinicians which patient to visit next
    b. Ability to sequence clinicians by indicating which room(s) are queued for them to visit and which room to visit next.
    c. Ability to override clinician sequencing to add a patient room as the next room in the clinician's queue.
    d. Supports procedure timer(s) for a preset period of time. When the timer is active the associated Dome Light and Nurse Console(s) will display a stutter flash and once the timer expires the Dome Light and Nurse Console(s) will show a flashing color.

e. Support for up to thirty two (32) unique indications at the associated Room Controller/Dome Light utilizing eight (8) colors (Green, Orange, Amber, Blue, White, Red, Pink, and Magenta) and four (4) dome light segments

12. Pocket Page Messaging

    a. Ability to send pocket page messages to on-duty staff within a Nurse Console's coverage area.
    b. Pocket page message can include a preset "tag" message or a free-form message using the touchscreen keyboard on the Nurse Console.

13. Room Swing and Day/Night Transfer:

    a. Ability for up to ten (10) pre-designated rooms to be temporarily rerouted ("swung") to a Nurse Console or Staff/Duty Terminal in an adjoining area. Once a room has been swung, all calls originating from that room will only annunciate at the other Console/Terminal. The Console/Terminal that swung the room shall be capable of returning the swung room to annunciate at the original Console/Terminal.
    b. Ability of all rooms reporting to a Nurse Console or Staff/Duty Terminal to be rerouted ("day/night transferred") to any other Console/Terminal in an adjoining area. Normal operation is restored to the original Console/Terminal when a staff member "releases" the day/night transfer.

14. The ability to service exchange Staff/Duty Terminal "hot" without removing system power or powering down the local Gateway.
15. Standard wall-mount and optional desk-stand mounting.

G. Patient Stations
Single Patient or Dual Patient Stations as shown on plans. Each station shall provide the following:

1. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Terminal.
2. Momentary action Cancel button, monitor LED indicator, and call-placed LED indicator.
3. RJ-45 field wiring receptacle for Cat-5e/6 wiring to associated Room Controller.
4. Blue LED to illuminate the station in low ambient light conditions.
5. Cancel button shall cancel any call on this station and other stations on the same Room Controller that are programmed for remote cancel.
6. Support for up to 3 levels of call-in per patient (Normal, Personal Attention, and Priority).
7. Support for up to 4 levels of service required per patient (Green, Orange, Yellow, and Stat).
8. One DIN receptacle (Single Patient) or two DIN receptacles (Dual Patient) providing:

    a. Support for a DIN Pillow Speaker or Call Cord.
    b. Tilt release design to eliminate receptacle damage when the pillow speaker/call cord is pulled from any angle.
    c. Station requires no dummy plugs and also includes a configurable option to require dummy plugs if so desired.
    d. "Cord out" call placement if pillow speaker or call cord is inadvertently removed with cord-out bypass feature allowing intentional removal of DIN pillow speaker or call cord without requiring a dummy plug.
    e. Ability to program the call priority level on a per patient/bed basis for a Dual Patient Station.

9. Continuous supervision of the Station for power and data with central notification of any supervision errors.
10. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.
11. Unit shall mount in a standard UL recognized 2-gang or 3-gang electrical box.
12. Optional features:

    a. One ¼ inch receptacle (Single Patient) or two ¼ inch receptacles (Dual Patient) for use with ¼ inch call cords or for auxiliary alarm input.
    b. Support for up to three (3) additional levels of call-in per Pillow Speaker providing a total of four (4) levels of call-in.
    c. Support for a remote DIN receptacle associated with single patient station allowing remote pillow speaker or call cord operation within the same room as the patient station.
    d. Muting of entertainment audio over DIN pillow speaker when intercom is in use.
    e. Full duplex audio to the Enhanced DIN pillow speaker.
    f. Associated lighting control isolation module.
    g. Feature bed (Stryker, Hill-Rom) support including call-in, entertainment and light control, bed unplugged indicator, and bed exit alarm; one connection per bed for feature beds.
    h. Two programmable feature buttons with field customizable labels. Default operation of feature buttons shall be Code Blue and Staff Emergency.
    i. Ability to set privacy mode at the station. Privacy mode prevents staff from calling into the room and listening to the patient while calls initiated from the room still support a two way audio connection.
    j. Ability to place a Routine call from a button on the front of the station.

13. Optional 22 gauge stainless steel security station cover for the single patient station supporting call placement with call assurance LED from a DIN call cord or pillow speaker, call cancel button, full duplex intercom audio, and the ability to receive audio pages.

H. Pull-Cord Intercom or Bath Intercom Stations
Each station shall provide the following:

1. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Terminal.
2. A momentary action Cancel button, monitor LED indicator, call-placed LED indicator, and the ability to place two call priorities from the same station; one call priority from the momentary action Call button and another call priority from the Pull Cord.
3. Six (6) foot, cut-to-length, PVC pull-cord for call placement with plastic cord guide and large easy to pull plastic “bell” attached.
4. Call from station may be configured to be canceled remotely from Nurse Console, Staff Terminal, remotely within the same room, by staff registering into the room, or only from the originating station.
5. Blue LED to illuminate the station in low ambient light conditions.
6. Continuous supervision of the Station for power and data with central notification of any supervision errors.
7. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.
8. Unit shall mount in a standard UL recognized 2-gang electrical box.

I. Behavioral Security Intercom Stations
Each station shall provide the following:

1. 11 gauge stainless steel construction, flush mount.

2. Full duplex audio utilizing a 2 ½ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Staff Terminal.
3. Momentary action call button.
4. Continuous supervision of the Station for power and data with central notification of any supervision errors.
5. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.
6. Individual Behavioral Security Stations options shall be:

    a. Intercom Call Station
    Active call from station can only be cleared remotely from a Nurse Console or Staff Terminal.
    b. Intercom Call Station with Cancel
    Active call from station can be cleared remotely from a Nurse Console or Staff Terminal or by the cancel button on the station.
    c. Intercom Call Station with Remote Keyswitch Activation

        1) A remote Keyswitch Station, outside of a secured room with the Intercom Call Station, can enable and disable the ability for the Intercom Call Station to place a call.
        2) An active call from the Intercom Call Station can only be cleared from the Keyswitch Station.

J. Behavioral Security Call Station
Each station shall provide the following:

1. 11 gauge stainless steel construction, flush mount.
2. Momentary action call button with call assurance LED indicator
3. Momentary cancel button
4. Continuous supervision of the Station for power and data with central notification of any supervision errors.
5. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.

K. Staff Stations
Each station shall provide the following:

1. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Terminal.
2. Momentary action call button, cancel button, monitor LED indicator, and call-placed LED indicator.
3. Cancel button shall cancel any call on this station and other stations in the same room that are programmed for remote cancel.
4. Call from station may be configured to be canceled remotely from Nurse Console, Staff Terminal, remotely within the same room, by staff registering into the room, or only from the originating station.
5. Blue LED to illuminate the station in low ambient light conditions.
6. Continuous supervision of the Station for power and data with central notification of any supervision errors.
7. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.
8. Unit shall mount in a standard UL recognized 2-gang electrical box.

9. Optional 22 gauge stainless steel station security cover supporting call placement button with call assurance LED, call cancel button, full duplex intercom audio, and the ability to receive audio pages.

L. Duty Stations
Each station shall provide the following:

1. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Terminal.
2. Four (4) LED call status indicators with 180° visibility to annunciate calls grouped into one of four main categories: routine, urgent, emergency, code. Customized call tones match tones at Nurse Console.
3. Momentary action call button with call placed LED indicator, monitor LED indicator, and momentary action Cancel/Tone Silence button. When call tone is temporarily silenced, the tones regenerate with a subsequent call annunciation to the respective Duty Station. This functionality can be disabled during system configuration so that call tones cannot be muted.
4. Call from station may be configured to be canceled remotely from Nurse Console, Staff Terminal, remotely within the same room, by staff registering into the room, or only from the originating station.
5. Blue LED to illuminate the station in low ambient light conditions.
6. Continuous supervision of the Station for power and data with central notification of any supervision errors.
7. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.
8. Unit shall mount in a standard UL recognized 2-gang electrical box.

M. Visual Duty Stations
Each station shall provide the following:

1. Four (4) LED call status indicators to annunciate calls grouped into one of four main categories: routine, urgent, emergency, code. Customized call tones match tones at Nurse Console with an adjustable day/night tone level.
2. Momentary action tone silence button. When call tone is temporarily silenced, the tones regenerate with a subsequent call annunciation to the respective Duty Station. This functionality can be disabled during system configuration so that call tones cannot be muted.
3. Blue LED to illuminate the station in low ambient light conditions.
4. Continuous supervision of the Station for power and data with central notification of any supervision errors.
5. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.
6. Unit shall mount in a standard UL recognized 1-gang electrical box.

N. Room Controllers
Each Room Controller shall provide the following:

1. Provides power, data, audio and control for up to fifteen (15) Room Stations (intercom and peripheral) within a specific room or area.
2. Unit shall mount in a standard UL recognized 2-gang electrical box.
3. Continuous supervision of the Room Stations with LED indicator of proper operation or fault condition.
4. The ability to service exchange Room Controller “hot” without removing system power or powering down the local Gateway.
5. Unit shall mount in a standard UL recognized 1-gang or 2-gang electrical box.

O. Room Controllers with integrated Dome Light
Each Dome Light shall provide the following:

1. Provides power, data, audio and control for up to fifteen (15) Room Stations (intercom and peripheral) within a specific room or area.
2. Indicate the highest level call priority within a specific room or area using maintenance free LED indicators of the following colors: white and red. Depending on the call priority the indicators can light solid or flash.
3. Indicate the highest level call priority and service requirement or staff presence within a specific room or area using maintenance free LED indicators capable of producing a minimum of the following eight (8) colors in over forty (40) color/pattern combinations: white, red, yellow, orange, green, blue, magenta and pink and to be displayed with five (5) light patterns: steady, slow flash, fast flash, sequence slow, and sequence fast. The ability, for semi-private rooms, to uniquely indicate calls from each of the two beds.
4. A translucent lens and four section with opaque partitions separating the sections.
5. Dome Light housing and lens resist damage by common hospital cleaning agents.
6. Continuous supervision of the Dome Light and Room Stations with LED indicator of proper operation or fault condition. In the unexpected event of communications loss with the Nurse Call Gateway, the Dome Light enters a local room failsafe mode and continues to visually indicate local calls.
7. The ability to service exchange Room Controller “hot” without removing system power or powering down the local Gateway.
8. Unit shall mount in a standard UL recognized 1-gang or 2-gang electrical box.
9. Optional 22 gauge stainless steel security corridor light cover supporting visibility of all four dome light segments.

P. Zone Lights
Each Zone Light shall provide the following:

1. Programmable to indicate the highest level call within zone light areas using maintenance free LED indicators of the following colors: white and red. Depending on the call priority the indicators can light solid or flash.
2. Multi-color Zone Lights: maintenance free LED indicators capable of producing a minimum of the following 8 colors in over 40 color/pattern combinations: white, red, yellow, orange, green, blue, magenta and pink and to be displayed with five light patterns: steady, slow flash, fast flash, sequence slow, and sequence fastA translucent lens and four section with opaque partitions separating the sections.
3. Dome Light housing and lens resist damage from common hospital cleaning agents.
4. Continuous supervision of the Zone Light with LED indicator of proper operation or fault condition.
5. The ability to service exchange Zone Light “hot” without removing system power or powering down the local Gateway.
6. Unit shall mount in a standard UL recognized 1-gang or 2-gang electrical box.
7. Optional 22 gauge stainless steel security corridor light cover supporting visibility of all four zone light segments.

Q. Peripheral Stations
The following peripheral stations as shown on plans, associated with Room Controllers.
Each Peripheral Station shall provide the following:

1. A momentary cancel button to both cancel calls from the station itself and the ability to remote cancel calls on other stations associated with the same Room Controller.
2. Call(s) from station may be configured to be canceled remotely from Nurse Console, Staff Terminal, remotely within the same room, by staff registering into the room, or only from the originating station.

3. LED indicator associated with any button or jack that places a call, initiates a procedure, or registers a staff member.
4. Full duplex audio through associated intercom station associated with the same Room Controller.
5. A blue LED to illuminate the station in low ambient light conditions.
6. Continuous supervision of the Station for power and data with central notification of any supervision errors.
7. The ability to service exchange Station “hot” without removing system power or powering down the local Gateway.
8. Unit shall mount in a UL recognized 1-gang electrical box.
9. Individual Peripheral Stations shall be:

    a. Single Level Pushbutton Station:

        1) Momentary call button with customizable call priority label insert.
        2) Optional 22 gauge stainless steel station security cover supporting call placement button with call assurance LED and call cancel button.

    b. Single Level Large Pushbutton Station:

        1) Momentary call button preconfigured as “Code Blue or “Code Pink”.
        2) Elapsed timer output to start a count up timer on any clock that accepts a remote timer input.

    c. Pull-Cord Pushbutton Emergency Station:

        1) Six (6) foot, cut-to-length, PVC pull-cord with plastic cord guide and large easy to pull plastic “bell” attached.
        2) Momentary action call button with the ability to place the same or different call priority than the pull cord.

    d. Pull-Cord Pushbutton Emergency Shower Station:

        1) Six (6) foot, cut-to-length, PVC pull-cord with plastic cord guide and large easy to pull plastic “bell” attached.
        2) Momentary action call button with the ability to place the same or different call priority than the pull cord.
        3) Wall gasket and waterproof design allowing direct application of water spray from a shower stall or similar type installation.

    e. Dual Level Pushbutton Station:

        1) Two (2) momentary action call buttons each with a different call priority and the ability to customize the call priority and associated label insert. Default call priorities are Emergency and Code.

    f. Staff Registration Station:
        1) Three (3) individually latching buttons supporting three (3) levels of staff presence: Green, Orange, and Amber.

    g. Auxiliary Alarm Input Station:

        1) Two (2) 1/4 inch jacks for the connection of external patient monitoring devices:

a) Individually programmable call priority level per jack each with a customizable call priority label insert.
b) Ability to associate multiple Auxiliary Alarm Input Stations with the same room controller in turn supporting up to a total of thirty (30) unique alarm input call priorities.
c) Configurable for latching or non-latching inputs.
d) No dummy plugs required.

h. Workflow and Procedure Station
Station options for four (4) or eight (8) buttons with the ability to customize each button and the associated label insert for the following types of functionality:

1) Staff registration
2) Remote cancel
3) Call placement
4) Workflow event
5) Rounding
6) Reminder
7) Clinic Operation:

a) Ability to “room” a patient and direct clinicians which patient to visit next
b) Ability to sequence clinicians by indicating which room(s) are queued for them to visit and which room to visit next.
c) Ability to override clinician sequencing to add a patient room as the next room in the clinician’s queue.
d) Supports procedure timer(s) for a preset period of time. When the timer is active the associated Dome Light and Nurse Console(s) will display a stutter flash and once the timer expires the Dome Light and Nurse Console(s) will show a flashing color.
e) Support for up to four (4) or eight (8) unique indications at the associated Room Controller/Dome Light utilizing eight (8) colors (Green, Orange, Amber, Blue, White, Red, Pink, and Magenta) and four (4) dome light segments

i. Remote Cancel Station:

1) A momentary cancel button to remote cancel calls on other stations associated with the same Room Controller.

R. Smart Bed Interface
Each module shall provide the following:

1. Input for up to eight (8) outputs from an associated smart bed.
2. Continuous supervision of the Smart Bed Interface for power and data with central notification of any supervision errors.
3. The ability to service exchange Smart Bed Interface “hot” without removing system power or powering down the local Gateway.
4. Unit shall mount in a UL recognized 1-gang electrical box.

S. Pillow Speakers

1. Provide one (1) Pillow Speaker per Single Patient Station and two (2) Pillow Speakers per Dual Patient Station with an additional 5% as spares. Each Pillow Speaker shall provide:

    a. Molded ABS plastic case and controls.
    b. An integral grill with speaker/microphone.
    c. Nurse call button.
    d. Ten (10) foot vinyl-insulated cord with electrostatic discharge protection and molded strain relief at each end.
    e. Spring-type metal bed clip.
    f. Molded plastic plug with 8-pin DIN connector.
    g. Optional features:

        1) Two (2) auxiliary buttons for control of in-room lighting or other in-room devices.

    h. There shall be three different pillow speaker models available *(specification writer choose one model below)*:

        1) Standard:

            a) TV channel up and down buttons.
            b) TV volume up, volume down, and mute buttons.
            c) TV power button.
            d) TV closed caption button.

        2) Direct Access:

            a) TV channel 10-digit direct access buttons.
            b) TV channel up and down buttons.
            c) TV volume up, volume down, and mute buttons.
            d) TV power button.
            e) TV closed caption button.

        3) Enhanced:

            a) Four call-in buttons with associated LED call placed indicators: “nurse”, “pain”, “water”, and “toilet”.
            b) Full duplex audio to the pillow speaker via built-in microphone and separate speaker.
            c) Night light to illuminate the pillow speaker in low ambient light conditions.
            d) TV channel 10-digit direct access buttons.
            e) TV channel up and down buttons.
            f) TV volume up, volume down, and mute buttons.
            g) TV power button.
            h) TV closed caption button.
            i) Two (2) auxiliary buttons for control of in-room lighting or other in-room devices.

T. Remote DIN Station
One (1) Remote DIN Station per Single Patient Station. Each Remote DIN Station shall provide the following:

1. One (1) 8-pin DIN jack for remote connection of a pillow speaker or DIN call cord.
2. Full-duplex audio communication to the pillow speaker.
3. Pillow speaker support for up to four levels of call-in, TV control with audio, and light control.
4. Muting of entertainment audio to the pillow speaker during intercom communication.
5. “Cord out” call placement if pillow speaker or call cord is inadvertently removed with cord-out bypass feature allowing intentional removal of DIN pillow speaker or call cord without requiring a dummy plug
6. Unit shall mount in a UL recognized 1-gang electrical box.

U. Feature Bed Receptacles
Provide as shown on plans one (1) Feature Bed Receptacle per Single Patient Station and two (2) Feature Bed Receptacles per Dual Patient Station. Feature Bed Receptacle shall provide:

1. Simple means to connect Feature Bed to Patient Station.
2. Capable of providing the following (depending on the functionality included with the bed siderail):

    a. TV: Channel Up, Channel Down, Volume, On/Off.
    b. Up Light on/off.
    c. Down Light on/off.
    d. Bed Exit.
    e. Entertainment muting during intercom with transfer of intercom audio to bed side rails.

3. Supervision of bed connection

    a. Alarm call through Patient Station if bed is disconnected.
    b. Inserting dummy plug, tethered to Bed Receptacle, cancels Alarm Call.

4. Unit shall mount in a UL recognized 1-gang electrical box.

V. Call Cords
Provide Standard and Specialty Call Cords as required:

1. Standard Call Cord:

    a. Ten (10) foot vinyl jacketed cord.
    b. Thermoplastic pendant with momentary contact nurse call pushbutton.
    c. 8-pin DIN connector.
    d. Metal bed clip.
    e. Strain relief at both ends.

2. Sealed Call Cord:

    a. Ten (10) foot vinyl jacketed cord.
    b. Thermoplastic pendant with sealed momentary contact nurse call pushbutton.
    c. Night light to illuminate the call cord pendant in low ambient light conditions.
    d. 8-pin DIN connector.
    e. Metal bed clip.
    f. Strain relief at both ends.

3. Specialty Geriatric Call Cord:

a. Bulb and Cord: six (6) foot gray non-toxic tubing with matching molded air bulb.
b. 8-pin DIN connector.
c. Metal bed clip.

4. Specialty Breath Activated Call Cord:

a. Conduit: Plastic covered, three (3) foot heavy-duty flexible metal conduit.
b. Straw: 2 inch x 5/16 inch diameter clear vinyl straw (12 provided).
c. Cord: 9 foot x 5/16 inch diameter grey plastic tubing.
d. Connector: 1/4 inch phone-type plug.

W. LAN-Based Software and Integration options supporting:

1. Microsoft Active Directory (AD) for a single sign-on to both the facility's LAN and any associated nurse call applications. Systems which require users to manage a separate sign on and password for nurse call applications are unacceptable.
2. Server virtualization to run nurse call software and integration options. Systems which require dedicated hardware servers for nurse call software and integration are unacceptable.
3. The available software and integration options are:

a. Reporting Software Package – optional
Providing the following:

1) SQL database logging of all nurse call activity, text messaging sent to phones, smart devices, and pagers, calls sent to phones, and staff response to active calls, across the entire Nurse Call Network.
2) Multiple report generation options including Summarized Call Statistics, Hourly Call Statistics, Call Exception (staff voice and in-person response outside of desired time), Detailed Patient Activity, Summary Patient Activity, System-Wide Activity, Current Staff Assignment, Staff Assignment History, Patient Wait Time (for clinic applications), and Staff Activity (for clinic applications).
3) Ability to generate the reports in either PDF or Excel formats.
4) Remote report generation capability from any networked PC work station on the facility's LAN.
5) Support for an unlimited number of concurrent users to access report generation. Any limit to the number of users accessing the software is unacceptable.
6) Ability to automatically email predefined reports at reoccurring periods. The time periods can be configured for a specific time every day, day of the week, every other week, or monthly. The reports will automatically update the data to "roll" with the reoccurring time periods when the reports are emailed.

b. Smart Device Text Alerting – optional
Provide an Android-Based Text Alerting Interface:

1) Text alerting application on wireless smart device supports Android version 6.0 and later.
2) On the caregiver's wireless phone/tablet:

a) Over the facility's LAN, automatically route text alerts of active calls, workflows, expired rounding, and active timers to caregiver(s)

smartphone/tablet including the call priority, calling room, bed, and call duration timer.
b) Tone and/or vibrate alerting of active calls.
c) Displays up to eight (8) active calls at a time with the ability to scroll to see additional calls.
d) Automatically prioritization of displayed active calls so that the highest priority and longest active calls are at the top of the display.
e) Ability to Accept or Reject a displayed active call.
f) Accepting a call will alert all other device with the name of the caregiver accepting the call.
g) Rejecting a call will gray out the active call from the caregiver's device.
h) Displays active patient and staff calls on smart device's lock screen.
i) Caregiver can manage their own On/Off Duty and Break status for when they will receive active call alerts.

c. Pocket Page and Text Messaging Interface – optional
Providing the following:

1) Using industry standard TAP protocol to transmit informational messages and patient call information to the facility's pocket page encoder/transmitter or middleware for text messaging over a wireless device carried by staff members.
2) Call notification/display to the caregiver's pocket pager/wireless device includes calling room, bed, call priority, and optional "tag" message.
3) Supporting three programmable operating modes for each hospital unit/ward. Regardless of the mode of operation, all calls will continue to annunciate at respective Duty Stations, Nurse Consoles, and Staff Terminals:

a) Manual Mode – from a Nurse Console or Staff/Duty Terminal, staff members can manually initiate a message to any caregiver's pocket pager/wireless device.
b) Automatic Mode – always route patient calls from patients to their assigned caregiver's pocket pager/wireless device.
c) Semi-Automatic – from a Nurse Console or Staff/Duty Terminal staff members selectively initiate pocket page/wireless device notification to assigned caregivers by setting a service requirement. As part of the service requirement the staff member may include an informational "tag" message detailing patient's needs.

4) If a call is not cleared within a preprogrammed time period the pocket page/text message will automatically route to the next assigned staff member's pager/wireless device.
5) Over any PC on the facility's LAN support:

a) The ability to assign of up to three caregivers for each patient for up to three shifts within a 24 hour period.
b) Customize which call priorities route first, second, or third to each of the assigned caregivers.
c) Create multiple crash teams and group notifications based on specific call priorities and/or units. Group/crash team pages will automatically display on all pocket pagers for caregivers assigned to that group/crash team.

d) Support for an unlimited number of concurrent users to access staff assignment software. Any limit to the number of users accessing the software is unacceptable.
e) Barcode scanner assignment of pocket pagers/wireless devices to staff members, staff on/off duty, and staff on/off break status with automatic call rollover to backup team members while “on break”.

6) Patients without one or more assigned caregivers shall automatically route to a unit-wide backup pocket pager/wireless device to ensure no patient call is missed.
7) Support for team alerts which routes text alerts of patient and staff calls to multiple pocket pagers/wireless devices simultaneously.
8) Notification of system errors automatically sent to a designated technician’s pocket pager/wireless device.

d. SIP Facility-Wide Wireless Phone Interface – optional
Providing the following:

1) Utilize the Session Initiation Protocol (SIP) standard to route patient and staff calls from the Nurse Call Network to wireless SIP phones carried by staff members.
2) Call notification and display to caregiver’s wireless SIP-based phone including calling room, bed, and call priority. Upon notification of a call, from the wireless phone the caregiver can answer the call and:

a) Establish full-duplex audio communication with the calling Patient, Staff, or Duty Station
b) Using the telephone’s keypad, set a service requirement (Green, Orange, Amber, or Stat) for the calling patient to direct the call to other caregiver’s assigned to this same patient.
c) Using the telephone’s keypad, upgrade the call to a Priority call to route the call to all caregiver’s assigned to the patient.

3) Ability to dial directly to patient rooms and staff areas to communicate over the associated Patient, Staff, or Duty Station.
4) Support for three programmable operating modes for each hospital unit/ward. Regardless of the mode of operation, all calls will continue to annunciate at respective Duty Stations, Nurse Consoles, and Staff Terminals:

a) Manual Mode – from a Nurse Console or Staff/Duty Terminal, staff members can manually initiate a text message to any caregiver’s wireless phone.
b) Automatic Mode– always route patient calls from patients to their assigned caregiver’s wireless phone.
c) Semi-Automatic – from a Nurse Console or Staff/Duty Terminal staff members selectively initiates wireless phone notification to assigned caregivers by setting a service requirement. As part of the service requirement the staff member may include an informational “tag” message detailing patient’s needs.

5) If a patient call is not cleared within a preprogrammed time period the call notification will automatically route to the next assigned staff member’s wireless phone.

6) Patients without an assigned caregiver shall automatically route to a unit-wide backup SIP wireless phone to ensure no patient call is missed.
7) Support for team alerts which route text only alerts of patient and staff calls to multiple SIP phones simultaneously.
8) Over any PC on the facility's LAN support:

    a) The ability to assign of up to three caregivers for each patient for up to three shifts within a 24 hour period.
    b) Customize which call priorities route first, second, or third to each of the assigned caregivers.
    c) Create multiple crash teams and group notifications based on specific call priorities and/or units. SIP based group notifications will automatically display on all wireless phones for caregivers assigned to that group/crash team.
    d) Support for an unlimited number of concurrent users to access staff assignment software. Any limit to the number of users accessing the software is unacceptable.
    e) Barcode scanner assignment of pocket pagers/wireless devices to staff members, staff on/off duty, and staff on/off break status with automatic call rollover to backup team members while "on break".

9) Employ a Networked Nurse Call System architecture and SIP licensing scheme to eliminate calls from not routing to SIP phones because of limited resources. Any blocking of wireless phones being able to answer calls because of limited resources is unacceptable.

e. LAN-Based PC Console Display Software – optional
Providing the following:

1) Remote access to PC Console Display from any networked PC work station on the facility's LAN.
2) Ability to run in either an independent or associated mode:

    a) Independent mode supports filtering to show all or specific call priorities and workflow events, for one unit, several units, or the entire Nurse Call Network.
    b) Associated mode works in tandem with a Nurse Console. Selecting an active call on the PC Console Display will answer the call on the associated Nurse Console.

3) Capable of three different views of call and patient information:

    a) List View – showing up to six (6) active calls or events with the ability to scroll to see additional calls and events. The active calls and events are shown in order based on the highest priority and oldest active call or event at the beginning of the list. The list view also displays the active staff in the selected nursing unit(s) and the wireless devices assigned to them
    b) Whiteboard View – within a specific unit, list all the rooms/beds and any associated information including patient information, assigned caregivers, staff present, active call events and service reminders, and smart bed status.

c) Map View – within a specific unit display up to four (4) floor maps showing active calls with a count-up timer, active service requests and current staff locations.

4) Support for an unlimited number of concurrent users to access PC Console Display software. Any limit to the number of users accessing the software is unacceptable.

f. RTLS (Real Time Locating System) Interface – optional
Providing the following:

1) System is capable of integrating to 3rd party real-time locating system for precise identification and location of caregivers throughout the facility. The caregiver's name and level (Green, Orange, Amber) is displayed on the Nurse Consoles and Staff Terminals.
2) RTLS Staff locating supports all staff registration features at the Nurse Console and patient room including:

a) Ability to locate caregivers closest to a calling room.
b) Upon registering into the room, any outstanding Service Requirements matching the staff level or any outstanding patient calls from the Patient Station, configured for remote cancel, will be automatically cleared.
c) Indication at the Dome Light of staff present within the respective patient room.

3) Over any PC on the facility's LAN support for barcode scanner assignment of locating tags to staff members.

g. Automated Voice Public Address System Interface – optional
Providing the following:

1) The ability to create automated computer voice generated announcements of specific call priorities to announce over the facility's public address system. Each customized message can include the calling room number, room description, call priority, location within the facility, and instructions. The message can sound one or more times and an optional second announcement can occur when a call has been cleared.
2) Support for up to thirty one (31) zoned outputs to the facility's public address system. Each output includes a line level output and a muting contact control.

h. ADT Interface – optional
Provide an HL-7 compliant interface (V2.2 – 2.4) to receive relevant patient information from the ADT system with the following functionality:

1) Mapping of standard ADT segment field components and subcomponents to nurse call fields.
2) Display of patient information at Nurse Consoles and Staff Terminals when a patient call is annunciated, when a patient call is answered, or when a patient room is dialed directly.
3) All updates shall be real time, but software shall buffer data for any interruption of service.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install wiring in raceway except within consoles, desks, and counters; and except in accessible ceiling spaces and in gypsum board partitions, where cable wiring method may be used. Use UL-listed CMP plenum-rated cable in environmental air spaces including plenum ceilings. Conceal cable and raceway wiring except in unfinished spaces.

B. Install cables without damaging conductors or jacket.

C. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips that will not damage media or raceway.

E. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

F. Wiring within Enclosures: Provide adequate length of conductors.

G. Separation of Wires: Run in separate raceways or, if exposed or in same enclosure, provide 12-inch minimum separation between conductors and adjacent parallel power wiring. Provide separation as recommended by equipment manufacturer for other conductors.

H. Identification of Conductors and Cables: Retain color-coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams. Label stations, controls, and indications using approved consistent nomenclature.

I. Category-6 or better wire termination will be connectorized according to ANSI Standard T568B.

J. Grounding Provisions: Comply with requirements in Divisions 27 Section “Information Technology Grounding” and 26 Section "Grounding and Bonding for Electrical Systems."

3.2 EXISTING SYSTEMS

A. The Owner will continue to occupy the nursing units where equipment will be replaced. Supplying contractor will coordinate work with administration for each nursing unit to obtain a group of rooms per day for replacement of the nurse call equipment. The existing nurse call equipment must be maintained and operational during this replacement period except for the daily rooms being renovated.
-OR-

B. Remove all existing product and deliver to the Owner, or at the direction of the Owner, properly dispose of same.

C. Per the National Electrical Code, remove all unused or “dark” wiring utilized by the removed nurse call system.

D. The Owner will vacate one nursing unit at a time, making it available on a time table for the installation of the new equipment.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: A factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Test Procedure: Comply with the following:

1. Schedule tests a minimum of seven (7) days in advance of performance of tests.
2. Report: Submit a written record of test results.
3. Operational Test: Perform an operational system test, and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and all-call messages and pages at each nurse call station. Verify proper call-in routing and volume levels for each intercom station.

C. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets these Specifications and complies with applicable standards. Report results in writing.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

3.4 TRAINING

A. In-Service
Provide thorough training for all nursing staff assigned to those nursing units receiving a new or updated Nurse Call System. The training shall be given by the Manufacturer’s Clinical Training personnel and will include leave behind nurse call operation documentation and computer-based training CD. When multiple nursing units are involved, classes will be grouped and the periods of training shall be coordinated with the facility to ensure all nursing shifts receive the required training. All training shall be coordinated through the Education/Risk Management staff of the facility. Each session shall include instructions utilizing a factory prepared demonstration unit given by the Manufacturer’ Clinical Training personnel to provide “hands-on" practice operation of the system without affecting activity on a live system in the nursing unit. At no charge to the Client, to complement in-person training, on-line training sessions will be available that can be accessed throughout the Manufacturer’s specified warranty period.

B. Technical
Train facility’s maintenance personnel and caregiver staff to adjust, operate, and maintain nurse call equipment. This off-site training is available at the manufacturer’s facility to provide the best possible hands-on training experience. The cost of the technical training shall be at no charge, with the facility responsible for all travel, room and board expenses.

3.5 **DRAWINGS**

Provide as built drawings of all installed network components and associated wiring on building plans. Final payment for work will not be authorized unless these drawings are supplied.

END OF SECTION

SECTION 28 13 00
SECURITY ACCESS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes all labor, materials, tools, equipment and documentation for a complete and working integrated Security Management System. The security access system shall have the following:

1. Access Control:

   a. Regulating access through doors.
   b. Anti-passback.
   c. Visitor assignment.
   d. Time and attendance.
   e. Surge and tamper protection.
   f. Secondary alarm annunciator.
   g. Credential cards and readers.
   h. Enrollment center.
   i. Push-button switches.
   j. RS-232 ASCII interface.
   k. Credential creation and credential holder database and management.
   l. Monitoring of field-installed devices.
   m. Reporting.

2. Security:

   a. Real-time guard tour.
   b. Time and attendance.
   c. Key tracking.
   d. Video and camera control.
   e. Alarm management.
   f. Intrusion detection.
   g. Badging.
   h. Interface with elevator control systems.
   i. Metasys Integration.

B. Related Sections include the following:

1. Division 28 Section "Video Surveillance" for interface devices and communications protocol to integrate motion detection and video camera selection and positioning into security access system.
2. Division Section "Elevators" to add security access to elevator floor selection controls.

1.3 DEFINITIONS

A. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.

B. CCTV: Closed-circuit television.

C. Central Station: A PC with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.

D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

E. CPU: Central processing unit.

F. Credential: Data assigned to an entity and used to identify that entity.

G. dpi: Dots per inch.

H. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.

I. File Server: A PC in a network that stores the programs and data files shared by users.

J. GFI: Ground fault interrupter.

K. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

L. I/O: Input/Output.

M. LAN: Local area network.

N. LED: Light-emitting diode.

O. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.

P. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.

Q. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).

R. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.

S. RF: Radio frequency.

T. ROM: Read-only memory. ROM data are maintained through losses of power.

U. RS-232: A TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

V. RS-485: A TIA/EIA standard for multipoint communications.

W. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

X. TWAIN: (Technology without an Interesting Name.) A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

Y. UPS: Uninterruptible power supply.

Z. WAN: Wide area network.

AA. WAV: The digital audio format used in Microsoft Windows.

BB. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

CC. Windows: Operating system by Microsoft Corporation.

DD. Workstation: A PC with software that is configured for specific limited security system functions.

EE. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

1.4 SYSTEM DESCRIPTION

A. Existing system shall be expanded to include devices/components, as required for a full functional system.

1.5 PERFORMANCE REQUIREMENTS

A. Security access system shall use a single database for access-control and credential-creation functions.

B. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to Controllers so that each Controller makes access-control decisions for that Location. Do not use intermediate Controllers for access control.

1. Communications between the server (Host) and the CK720 controller panels can optionally support a redundant network path. Thus the loss of communications on the

primary network path automatically causes communications to be established via the other path without operator intervention.

2. Should the controller(s) lose communications with the Host, the controllers shall continue to control access and monitor inputs for all connected points. Local history of all transactions shall be buffered at the controller and automatically uploaded to the Host for alarm reporting and long-term historical storage once communications is re-established.
3. The contractor shall be responsible for the design of a system that will compensate for all signal level losses in the trunk wiring. This shall include any power supplies for the field devices and any signal level converters or repeaters for the proper amplification of electrical signals.

C. System Network Requirements:

1. Interconnect system components and provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response, and shall return to normal after partial or total network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and identify the communication link that has experienced a partial or total failure.
4. Communications Controller may be used as an interface between the Central Station display systems and the field device network. Communications Controller shall provide functions required to attain the specified network communications performance.

D. Central Station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central Station shall control system networks to interconnect all system components, including workstations and field-installed Controllers.

E. Field equipment shall include Controllers, sensors, and controls. Controllers shall serve as an interface between the Central Station and sensors and controls. Data exchange between the Central Station and the Controllers shall include down-line transmission of commands, software, and databases to Controllers. The up-line data exchange from the Controller to the Central Station shall include status data such as intrusion alarms, status reports, and entry-control records. Controllers are classified as alarm-annunciation or entry-control type.

F. System Response to Alarms: Field device network shall provide a system end-to-end response time of sixty (60) second(s) or less for every device connected to the system. The default setting for each input point reporting delay shall be 0 seconds. Alarms shall be annunciated at the Central Station within 1 second of the alarm occurring at a Controller or device controlled by a local Controller, and within 100 ms if the alarm occurs at the Central Station. Alarm and status changes shall be displayed within 100 ms after receipt of data by the Central Station. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. This response time shall be maintained during system heavy load.

G. False Alarm Reduction: The design of Central Station and Controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.

H. Error Detection: A cyclic code error detection method shall be used between Controllers and the Central Station, which shall detect single- and double-bit errors, burst errors of eight bits or less, and at least 99 percent of all other multibit and burst error conditions. Interactive or product error detection codes alone will not be acceptable. A message shall be in error if one bit is received incorrectly. System shall retransmit messages with detected errors. A two-digit decimal number shall be operator assignable to each communication link representing the

number of retransmission attempts. When the number of consecutive retransmission attempts equals the assigned quantity, the Central Station shall print a communication failure alarm message. System shall monitor the frequency of data transmission failure for display and logging.

I. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

J. Door Hardware Interface: Coordinate with Division 8 Sections that specify door hardware required to be monitored or controlled by the security access system. The Controllers in this Section shall have electrical characteristics that match the signal and power requirements of door hardware. Integrate door hardware specified in Division 8 Sections to function with the controls and PC-based software and hardware in this Section.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include operating characteristics, furnished specialties, and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings:

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.

4. Cable Administration Drawings: As specified in Part 3 "Identification" Article.
5. Battery and charger calculations for Central Station, workstations, and Controllers.

C. Project planning documents as specified in Part 3.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Microsoft Windows software documentation.
2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

4. System installation and setup guides, with data forms to plan and record options and setup decisions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

C. Source Limitations: Obtain Central Station, workstations, Controllers, Identifier readers, and all software through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70, "National Electrical Code."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.
3. Mark packing list with designations that have been assigned to materials and equipment for recording in the system labeling schedules that are generated by cable and asset management system specified in Part 2.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 1 enclosure.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122

deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph. NEMA 250, Type 4 enclosures.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Alarm Printer Black/Red Ribbons: Package of 12.
2. Laser Printers: Three toner cassettes and one replacement drum unit.
3. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
4. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.11 INTEGRATION REQUIREMENTS

A. Video Imaging System Integration. The SMS shall integrate with the Johnson Controls, Inc. P2000 Video Imaging and Badging system without the need for custom software development.

1. The integration shall provide for a single database on the SMS Host server, which shall store the cardholder data and image fields.
2. The communications between the video capture/badging station and the SMS host shall be via Ethernet TCP/IP only. Serial connections are unacceptable.
3. It shall be possible to operate the Video Badging and Workstation software from the same qualified OWT with Windows 95 or 98 operating system software.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SECURITY ACCESS SYSTEM

A. Manufacturers:

1. All access control hardware and software shall be of a single manufacturer including host system, controller panels, and input and output terminal modules.
2. System shall be Johnson Controls, Inc. P2000 to match existing.

2.3 APPLICATION SOFTWARE

A. The software shall have an installed capacity to accommodate the following at a minimum:

1. A central database on the host server able to support up to 200,000 Badges maximum.
2. Unlimited number of access groups.
3. Unlimited number of passwords groups each with an unlimited number operators and their passwords.
4. Up to 17,000 2-state alarm input points, or up to 8,000 4-state alarm input points (or any combination in-between).
5. Up to twenty-five (25) operator workstation terminals (OWT's) connected to a Host server via an Ethernet TCP/IP network.
6. Central on-line data storage of 500,000 historical transactions, expandable as system resources allow, with a local panel storage capability of up to 200,000 cardholders and 50,000 events.
7. 256 levels of alarm priority.
8. A minimum of ten (10) individual badge numbers per cardholder. Each badge shall be tracked separately.
9. Eight (8) issue levels per card, only one of which shall be active at any given time.
10. Unlimited number of user-defined cardholder fields. The system shall be capable of reporting on any or all of the user-defined fields. Each user defined field may be defined by the user as alphanumeric, numeric, data, or logical (yes/no).

B. System Software:

1. The Host server operating system shall be Microsoft Windows 2000 Server. It shall have multi-tasking and multi-user capability and support workstations with Windows NT Workstation, Windows 98, Windows ME, or Windows 2000 Professional operating systems.
2. The system database shall be Windows SQL Server 2000 for Windows 2000 Server or SQL Server 7.0 for Windows NT.
3. The SMS software features shall be fully documented in the form of a complete User's Manual including operation and installation sections, and a detailed description of the major SMS functions.

C. The SMS shall be capable of partitioning (segmenting) the database which must include, at least, but not limited to the following items:

1. Cardholders.
2. Badges.
3. Time zones.
4. Holidays.
5. Access Groups.
6. Panels.
7. Readers/Terminals.
8. Workstations.

D. Controller Software:

1. Controllers shall operate as an autonomous intelligent processing unit. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door locking schedules for its operation, independent of other system components. Controllers shall be part of a fully distributed processing control network. The portion of the database associated with a Controller and consisting of parameters, constraints, and

the latest value or status of points connected to that Controller, shall be maintained in the Controller.

2. Functions: The following functions shall be fully implemented and operational within each Controller:

   a. Monitoring inputs.
   b. Controlling outputs.
   c. Automatically reporting alarms to the Central Station.
   d. Reporting of sensor and output status to Central Station on request.
   e. Maintaining real time, automatically updated by the Central Station at least once a day.
   f. Communicating with the Central Station.
   g. Executing Controller resident programs.
   h. Diagnosing.
   i. Downloading and uploading data to and from the Central Station.

3. Sub-controllers shall be Johnson Controls, Inc. CK720/CK705 Version 2.0-00 or prior approved equal with the following functionality:

   a. The sub-controller shall be a fully stand-alone processor capable of making all access control decisions without the involvement of the Host computer based on a set of parameters passed to the sub-controller from the Host.
   b. The sub-controller shall support up to sixteen (16) card readers in addition to either 256 input points of 128 input points and 128 output points. It shall further support up to 12 facility codes per reader, 40 unique holidays, 8 access group and time zone pairs.
   c. Memory Requirements:

      1) Standard number of cards: 15,000 expandable to 200,000.
      2) Minimum number of historical transactions: 5,000 expandable to 50,000 at full card capacity.

   d. The controller shall require no firmware changes and shall use flash memory modules to provide non-volatile storage of both data and operational code.
   e. The controller shall support the direct connection of a standard dot matrix printer for local transaction and report printing. The printer shall connect to the controller via a built-in serial (RJ45) port.
   f. Each controller shall be provided with built-in hardware to support hard-wired communications between the controller(s) and readers of up to 4000 feet per
   g. Communications between the controller(s) and the host server shall be via Ethernet TC/IP at 10Mbps. There shall be an alternate communications path to the host via a secondary IP address such that in the unlikely event the primary IP address/network is down an alternate communications path may be established.
   h. An alarm summary relay shall be built-in to the controller motherboard. IF so programmed, the alarm relay shall be activated whenever a connected alarm point transfers to the alarm state and whenever soft alarms become active.
   i. A SPDT tamper switch shall be attached to the inner surface of the controller enclosure. The tamper switch shall change state whenever the enclosure door is opened to signal the SMS of the condition. The tamper switch input shall be user programmable to be suppressed, to be recognized as an input point to be process by the alarm queue at the host computer, to printout at an optional printer connected directly to the controller, and to activate the alarm summary relay described above.
   j. The standard AC linear power supply version of the controller shall include a battery module to back-up the controller’s applications programs and database for

30 days after the failure of the primary AC power service. The controller database, the time clock, the transaction history, and all operator entered parameters shall be backed-up by the battery.

k. If required elsewhere in the drawings or Specification, the controller(s) shall be furnished with an UPS battery configuration instead of a standard AC linear power supply configuration. The battery shall power the controller upon failure of the primary AC service for a minimum of three hours.

l. While on UPS service, the controller shall continue to process event activity, card transactions, and record history transactions.

m. The controller shall provide built-in LED to indicate whether the controller is properly communicating with the host computer.

4. Communications Monitoring:

a. System shall monitor and report status of RS-485 communications loop of each Location.

b. Communication status window shall display which Controllers are currently communicating, a total count of missed polls since midnight, and which Controller last missed a poll.

c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM memory for each Controller.

5. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the Central Station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

E. PC-to-Controller Communications:

1. Central-station or workstation communications shall use the following:

a. TCP/IP LAN network interface cards.

2. Direct serial, TCP/IP, and dial-up communications shall be alike in the monitoring or control of system, except for the connection that must first be made to a dial-up Location.

3. TCP/IP network interface card shall have an option to set the poll frequency and message response time-out settings.

4. PC-to-Controller and Controller-to-Controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications shall be verified and buffered and retransmitted if not acknowledged.

F. Direct Serial or TCP/IP PC-to-Controller Communications:

1. Communication software on the PC shall supervise the PC-to-Controller communications link.

2. Loss of communications to any Controller shall result in an alarm at all PCs running the communications software.

3. When communications are restored, all buffered events shall automatically upload to the PC, and any database changes shall be automatically sent to the Controller.

G. Controller-to-Controller Communications:

1. Controller-to-Controller Communications: RS-485, 4-wire, point-to-point, regenerative (repeater) communications network methodology.
2. RS-485 communications signal shall be regenerated at each Controller.

H. Database Downloads:

1. All data transmissions from PCs to a Location, and between Controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
2. If a Controller is reset for any reason, it shall automatically request and receive a database download from the PC. The download shall restore data stored at the Controller to their normal working state and shall take place with no operator intervention.
3. Software shall provide for setting downloads via dial-up connection to once per 24-hour period, with time selected by the operator.
4. Software shall provide for setting delays of database downloads for dial-up connections. Delays change the download from immediately to a delay ranging from 1 to 999 minutes.

I. Operator Interface:

1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:

    a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
    b. Maps to provide real-time display animation and allow for control of points assigned to them.
    c. System to allow inputs, outputs, and override groups to be placed on different maps.
    d. Software to allow changing the order or priority in which maps will be displayed.

7. Override Groups Containing I/Os:

    a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
    b. Icon shall change automatically to show the live summary status of points in that group.
    c. Override group icon shall provide a method to manually control or set to time zone points in the group.
    d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.

8. Schedule Overrides of I/Os and Override Groups:

    a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
    b. Each schedule shall be composed of a minimum of two dates with separate times for each date.
    c. The first time and date shall be assigned the override state that the point shall advance to, when the time and date become current.
    d. The second time and date shall be assigned the state that the point shall return to, when the time and date become current.

9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.

J. Operator Access Control:

1. Control operator access to system controls through three (3) password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
3. A minimum of thirty-two (32) passwords shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
4. The password shall not be displayed or printed.
5. Each password shall be definable and assignable for the following:

    a. Commands usable.
    b. Access to system software.
    c. Access to application software.
    d. Individual zones that are to be accessed.
    e. Access to database.

K. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged and processing shall start in not less than one (1) second(s).
3. Tasks that are executed by operator's commands shall include the following:

    a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
    b. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
    c. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.
    d. System Test: Allows the operator to initiate a system-wide operational test.
    e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
    f. Print reports.

g. Change Operator: Used for changing operators.
h. Display Graphics: Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
i. Run system tests.
j. Generate and format reports.
k. Request help with the system operation.

1) Include in main menus.
2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
3) Provide navigation to specific topic from within the first help window.
4) Help shall be accessible outside the applications program.

l. Entry-Control Commands:

1) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.
2) Arm or disarm each monitored input up to four times a day through time-zone programming.
3) Enable or disable readers or keypads up to twice a day through time-zone programming.
4) Enable or disable cards or codes up to four times per day per entry point through access-level programming.

4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:

a. Command entered is incorrect or incomplete.
b. Operator is restricted from using that command.
c. Command addresses a point that is disabled or out of service.
d. Command addresses a point that does not exist.
e. Command is outside the system's capacity.

L. Alarms:

1. System Setup:

a. Assign manual and automatic responses to incoming point status change or alarms.
b. Automatically respond to input with a link to other inputs, outputs, operator-response plans, unique sound with use of WAV files, and maps or images that graphically represent the point location.
c. 60-character message field for each alarm.
d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages. Setup shall assign messages to alarm originating device.
e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
f. Allow 25 secondary messages with a field of 4 lines of 60 characters each.

g. Store the most recent 1000 alarms for recall by the operator using the report generator.

2. Software Tamper:

a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond their authorization level.
c. Maintain a transcript file of the last 5000 commands entered at the each Central Station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
d. Allow only acknowledgment of software tamper alarms.

3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
5. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
6. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
7. Alarm Automation Interface: High-level interface to Central Station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in same manner as burglar alarms, using an RS-232 ASCII interface.
8. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
9. Camera Control: Provides operator ability to select and control cameras from graphic maps.

M. Alarm Monitoring: Monitor sensors, Controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.

1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
3. Maps shall automatically display the alarm condition for each input assigned to that map, if that option is selected for that input location.
4. Alarms initiate a status of "pending" and require the following two handling steps by operators:

a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.

5. Each workstation shall display the total pending alarms and total unresolved alarms.
6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
7. Alarms shall transmit to Central Station in real time, except for allowing connection time for dial-up locations.
8. Alarms shall be displayed and managed from a minimum of four different windows.

    a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
    b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
    c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
    d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.

9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
12. Identical alarms from same alarm point shall be acknowledged at same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
13. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and Controllers.
14. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

N. Alarm Graphics (maps): Existing alarm-graphics software shall be modified to include new additions to the Hospital. The alarm-graphics portion of the system shall provide dynamic color alarm graphic maps with the following functions:

1. User definable graphic maps to depict input and output point conditions, reader status, and sub-map attachments in the SMS.
2. The SMS shall support the importing of most bitmap file format graphics produced with any graphic drawing program such as x.TIF, x.BMP, or x.JPG file format. Vector file formats are not acceptable.
3. The SMS map program shall support the importing of most bitmap file format graphics to produce custom icons for all map attachments (input, output, reader, etc.).
4. The map display window shall have Home, Previous and Up level buttons for rapid movement among map levels. It shall also provide map selection and size adjustment lists.
5. The SMS software shall be capable of sorting a number of graphic maps. The quantity shall be limited by available hard disk storage space only.

    a. Input: Representing a user-defined alarm input point located anywhere in the system. The input point icon shall flash, change color, and the computer’s internal sounder shall beep when an alarm condition exits. It shall be possible to click on the icon to respond to the alarm condition or move directly to the alarm queue window to respond to the alarm. Each alarm-input icon shall have a pop-up box that indicates the point’s current state (open short, alarm/active, secure).

b. Output: Representing a user defined output point located anywhere in the SMS. It shall be possible to click on the icon to set or reset the output point. In addition, it can display the set or reset status of point.
c. May Layer: Representing that lower level maps associated with the top layer map exist in the system. It shall be possible to navigate through the map layers by clicking on the map layer (up and down) icons.
d. Reader Terminals: Reader icons shall have the capability of displaying" held open, forced open, locked, unlocked, unknown, override, up and down.
e. Panels: Representing a system panel controlled by the SMS. Panel icons shall have the capability of displaying the up or down status of the panel.
f. I/O Terminals: I/O terminal icons shall have the capability of displaying the up or down status.

O. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.

1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.

P. Report Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest priority activity. Report generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.

1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of period; and the default printer.
2. Printing on Requests: An operator may request a printout of any report.
3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm (such as door alarm, intrusion alarm, tamper alarm, etc.), the type of sensor, the location, the time, and the action taken.
4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
10. Who Is In (Muster) Report:

a. Emergency Muster Report: One click operation on toolbar launches report.
b. Cardholder Report. Contain a count of persons that are "In" at a selected Location and a count with detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.

11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that they are available on-site at all times.

12. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events or alarms only.
13. History Reports: Custom reports that allows the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.

    a. Initially store history on the hard disk of the host PC.
    b. Permit viewing of the history on workstations or print history to any system printer.
    c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
    d. Each report shall depict the date, time, event type, event description, device, or I/O name, cardholder group assignment, and cardholder name or code number.
    e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
    f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.

14. Reports shall have the following four options:

    a. View on screen.
    b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to system.
    c. "Save to File" with full path statement.
    d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

15. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:

    a. Active, inactive, or future activate or deactivate.
    b. Code number, name, or imprinted card number.
    c. Group, Location, access levels.
    d. Start and stop code range.
    e. Codes that have not been used since a selectable number of days.
    f. In, out, or either status.
    g. Codes with trace designation.

16. The reports of system database shall allow options so that every data field may be printed.
17. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.

Q. Anti-Passback:

1. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.
2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes though a reader of opposite designation.
3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting

the credential holder and the door involved in the violation. A separate report may be run on this event.

4. Timed Anti-Passback: A Controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.
5. The anti-passback schemes shall be definable for each individual door.
6. The Master Access Level shall override anti-passback.
7. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential holder population anti-passback status to a neutral status.

R. Visitor Assignment:

1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only access levels that have been designated as approved for visitors.
2. Provide an automated log of visitor name, time and doors accessed, and whom visitor contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. Security access system shall be able to restrict the access levels that may be assigned to credentials that are issued to visitors.
5. Allow operator to recall visitors' credential holder file, once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.
8. Specify start date and time permission for access is granted. If not specified then access is granted immediately.
9. Specify stop date and time for permission for access to expire. If not specified then access will not expire.

S. Time and Attendance:

1. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
2. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
3. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.

    a. Reports shall show in and out times for each day, total in time for each day, and a total in time for period specified by the user.
    b. Allow the operator to view and print the reports, or save the report to a file.
    c. Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.

T. Training Software: Enables operators to practice system operation including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

U. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. The enrollment station shall not have alarm response or acknowledgment functions.
2. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
3. The program shall provide means to disable the enrollment station when it is unattended to prevent unauthorized use.
4. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
5. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:

    a. MASK: Determines a specific format that data must comply with.
    b. REQUIRED: Operator is required to enter data into field before saving.
    c. UNIQUE: Data entered must be unique.
    d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
    e. NAME ID: Data entered will be considered a unique ID for the cardholder.

6. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
7. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
8. Batch card printing.
9. Default card data can be programmed to speed data entry for sites where most card data are similar.
10. Enhanced ACSII File Import Utility: Allows the importing of cardholder data and images.
11. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

2.4 System Database

A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.

B. Database Operations:

1. System data management shall be in a hierarchical menu tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
2. Navigational Aids:

    a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
    b. Point and click feature to facilitate data manipulation.

c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.

3. All data entry shall be automatically checked for duplicate and illegal data and shall verify that data are in a valid format.
4. Provide a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose the item was entered for, reasons for changes that were made, and the like.

C. File Management:

1. Provide database backup and restoration system, allowing selection of storage media, including 3.5-inch floppy disk, Zip and Jaz drives, and designated network resources.
2. Provide manual and automatic mode of backup operations. The number of automatic sequential backups before the oldest backup becomes overwritten; FIFO mode shall be operator selectable.
3. Backup program shall provide manual operation from any PC on the LAN and shall operate while system remains operational.

D. Operator Passwords:

1. Software shall support up to 32,000 individual system operators, each with a unique password.
2. Operator Password: One to eight alphanumeric characters.
3. Allow passwords to be case sensitive.
4. Passwords shall not be displayed when entered.
5. Provide each password with a unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:

a. Allow for at least 32,000 operator password profiles.
b. Predetermine the highest-level password profile for access to all functions and areas of program.
c. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
d. Restrict which doors an operator can assign access to.

6. Operators shall use a user name and password to log on to system.

a. This user name and password is used to access database areas and programs as determined by the associated profile.

7. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.

E. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).

1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
2. Use data-entry windows to view, edit, and issue access levels. Access authorization entry management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.
6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
8. Visitor Access: Issue a visitor badge, without assigning that person a card or code, for data tracking or photo ID purposes.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visual annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Allow each cardholder to be given either an unlimited number of uses or a number from 1 to 9998 that regulates the number of times the card can be used before it is automatically deactivated.
11. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

F. Security Access Integration:

1. Photo ID badging and photo verification shall use same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
2. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
3. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

G. Key control and tracking shall be an integrated function of cardholder data.

1. Provide the ability to store information about which conventional metal keys are issued and to whom, along with key construction information.
2. Reports shall be designed to list everyone that has possession of a specified key.

H. Facility Codes: System shall accommodate up to 2048 facility codes per Location, with the option of allowing facility codes to work at all doors or only particular doors.

I. Operator Comments:

1. With the press of one appropriate button on toolbar, the user shall be permitted to make operator comments into history at anytime.
2. Automatic prompting of operator comment shall occur before the resolution of each alarm.
3. Operator comments shall be recorded by time, date, and operator number.
4. Comments shall be sorted and viewed through reports and history.
5. The operator may enter comments in two ways; either or both may be used:

a. Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
b. Predefined and stored in database for retrieval on request.

6. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

J. Group:

1. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
2. System software shall have the capacity to assign 1 of 32,000 group names to an access authorization.
3. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
4. Allow sorting of history reports and code list printouts by group name.

K. Time Zones:

1. Each zone consists of a start and stop time for 7 days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.
3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.

L. Holidays:

1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time zone schedule for that 24-hour period.
2. Three separate holiday schedules may be applied to a time zone.
3. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in system and will not be purged.
4. Holidays not designated to occur each year shall be automatically purged from database after the date expires.

M. Access Levels:

1. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
2. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
3. System shall be able to create multiple door and time zone combinations under same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same Controller.

2.5 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 16 Section "Transient Voltage Suppression."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient Voltage Suppression" as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.6 CARD READERS

A. Power: Card reader shall be powered from its associated Controller, including its standby power source.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the Controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power on/off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Stripe Swipe Readers: Bidirectional, reading cards swiped in both directions, powered by the Controller. Reader shall be set up for magnetic-stripe encoding.

1. Readers for outdoors shall be a cold weather kit consisting of a heating element mounted inside the reader and moisture seal gasket set to prevent moisture from entering the reader housing, shall be installed in the reader to ensure normal operation.

F. Wiegand Swipe Reader: Set up for 33-bit data cards. Comply with SIA AC-01.

G. Wiegand Key Insert Reader: Set up for 33-bit data cards.

H. Touch Plate and Proximity Readers:

1. Active detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
2. Passive detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
3. The card reader shall read proximity cards in a range from contact with to at least 6 inches from the reader.

2.7 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Division 8 Section "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 8 Section "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power line supervision. Signal switches shall transmit data to Controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and shall report a forced entry. Power and signal shall be from the Controller. Electric strikes are specified in Division 8 "Finish Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the Controller. Electromagnetic locks are specified in Division 8 Section "Finish Hardware."

2.8 RS-232 ASCII INTERFACE SPECIFICATIONS

A. ASCII interface shall allow RS-232 connections to be made between the control station operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as CCTV switchers, intercoms, and paging systems.

1. Each alarm input in system shall allow for individual programming to output up to four unique ASCII character strings through two different COM ports on the host PC.
2. Each input shall have the ability to be defined to transmit a unique ASCII string for alarm and one for restore through one COM port, and a unique ASCII string for a nonalarm abnormal condition and one for a normal condition through the same or different COM port.
3. The predefined ASCII character strings shall have the ability to be up to 420 characters long with full use of all the ASCII control characters, such as return or line feed. The character strings shall be defined in database of system and then assigned to the appropriate inputs.
4. The COM ports of the host PC used to interface with external equipment shall be defined in the setup portion of the software. The COM port's baud rate, word length, stop bits, and parity shall be definable in the software to match that of the external equipment.

B. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.

1. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to the paging system. This interface shall support both numeric and alphanumeric pagers.

C. Alarm System Interface:

1. RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.
2. Alternatively, alarms that are received by this access control system are to be transferred to alarm automation system as if they were sent through a digital alarm receiver.

    a. System shall be able to transmit an individual message from any alarm input to a burglar alarm automation monitoring system.
    b. System shall be able to append to each message a predefined set of character strings as a prefix and suffix.

2.9 FLOOR SELECT ELEVATOR CONTROL

A. Elevator access control shall be integral to security access.

1. System shall be capable of providing full elevator security and control through use of CK720 controller.
2. Allow up to 16 elevators per CK720 and a maximum of 128 floors.
3. History of elevator activity shall be maintained in electronic or printed form.

B. Security access system shall record which call button is pressed, along with credential and time information.

1. System Controller shall record elevator access data.
2. The Controller shall reset all additional call buttons that may have been enabled by the user's credential.
3. The floor select elevator control shall allow for manual override either individually by floor or by cab as a group from a workstation PC.

2.10 REAL-TIME GUARD TOUR

A. Guard tour module shall provide the ability to plan, track, and route tours. Module shall input an alarm during tour if guard fails to make a station. Tours can be programmed for sequential or random tour-station order.

1. Guard tour setup shall define specific routes or tours for the guard to take, with time restrictions in which to reach every predefined tour station.
2. Guard tour activity shall be automatically logged to the central-station PC's hard drive.
3. If the guard is early or late to a tour station, a unique alarm per station shall appear at the Central Station to indicate the time and station.
4. Guard tour setup shall allow the tours to be executed sequentially or in a random order with an overall time limit set for the entire tour instead of individual times for each tour station.
5. Setup shall allow recording of predefined responses that will display for the operator at the control station should a "Failed to Check-in" alarm occur.
6. Support 256 user defined guard tours with a maximum of three guards per tour.

2.11 VIDEO AND CAMERA CONTROL

A. Control station or designated workstation displays live video from a CCTV source.

1. Control Buttons: On the display window, with separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan, and a minimum of two custom command auxiliary controls.
2. Provide at least seven icons to represent different types of cameras, with ability to import custom icons. Provide option for display of icons on graphic maps to represent their physical location.
3. Provide the alarm-handling window with a command button that will display the camera associated with the alarm point.

B. Display mouse-selectable icons representing each camera source, to select source to be displayed. For CCTV sources that are connected to a video switcher, control station shall automatically send control commands through a COM port to display the requested camera when the camera icon is selected.

C. Allow cameras with preset positioning to be defined by displaying a different icon for each of the presets. Provide control with Next and Previous buttons to allow operator to cycle quickly through the preset positions.

2.12 CABLES

A. Comply with Division 26 Section "Voice and Data Communication Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of Controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each Controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Contracting."

B. Install cables and wiring according to requirements in Division 26 Section "Voice and Data Communication Cabling."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5E rating of components and that ensure Category 5E performance of completed and linked signal paths, end to end.

F. Install cables without damaging conductors, shield, or jacket.

G. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

H. Install end-of-line resistors at the field device location and not at the Controller or panel location.

3.4 CABLE APPLICATION

A. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. RS-232 Cabling: Install at a maximum distance of 50 feet.

D. RS-485 Cabling: Install at a maximum distance of 4000 feet.

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet, and install No. 20 AWG wire if maximum distance is 500 feet.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed 250 feet.

G. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of 25 feet.

3.5 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

A. Install card, fob.

3.7 IDENTIFICATION

A. In addition to requirements in this Article, comply with applicable requirements in Division 26 Section "Electrical Identification" and with TIA/EIA-606.

B. Using cable and asset management software specified in Part 2, develop Cable Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE

A. Develop, install, and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, "Commercial Building Telecommunications Cabling Standards – Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end

performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

D. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.

1. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured, with an activated burglar alarm and access-control system reporting to a Central Station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. Refer to Division 1 Section "Closeout Procedures."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION

SECTION 28 23 00

VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Entire Divisions 26 and 27.

1.2 SUMMARY

A. This Section includes extension of existing video surveillance system.

B. Video surveillance system shall be integrated with monitoring and control system specified in Division 28 Section "Security Access" that specifies systems integration.

1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. B/W: Black and white.

C. CCD: Charge-coupled device.

D. MPEG: Moving picture experts group.

E. NTSC: National Television System Committee.

F. UPS: Uninterruptible power supply.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
3. UPS: Sizing calculations.
4. Wiring Diagrams: Power, signal, and control wiring, and grounding.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Manufacturer Seismic Qualification Certification: Submit certification that cameras, camera-supporting equipment, accessories, and components will withstand seismic forces defined in Division 26 Section "Seismic Controls for Electrical Work." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, video recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NECA 1.

C. Comply with NFPA 70.

D. Electronic data exchange between video surveillance system with an access control system shall comply with SIA TVAC.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 1 enclosures.
   2. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph thick. NEMA 250, Type 3R enclosures.
   3. Security Environment: Vandal Resistant Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: Two (2) years from date of final acceptance by Owner.

PART 2 - PRODUCTS

2.1 SUPPLIER

A. All cameras, licenses, and corresponding video surveillance equipment and accessories shall be purchased from American Digital Security, 140 Westwoods Dr., Liberty MO 64068, (816)415-4237.

2.2 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

   1. Manufacturers: Subject to compliance with requirements, provide to match existing devices. The current SLHS surveillance system is Avigilon. Components must be compatible with that system and cameras must be IP.

2.3 SYSTEM REQUIREMENTS

A. Add new device and modify existing system as required for the new addition.

B. Video signal format shall comply with the NTSC standard composite video, interlaced.

C. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient Voltage Suppression."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient Voltage Suppression" as recommended by manufacturer for type of line being protected.

D. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.4 STANDARD CAMERAS

A. Acceptable Manufacturers:

1. Avigilon.

B. Cameras:

http://avigilon.com/support-and-downloads/for-software/acc/supported-cameras-and-encoders/

C. Licenses:

1. Provide an Avigilon license for each new camera provided on the project.

2.5 LENSES

A. Acceptable Manufacturers:

http://avigilon.com/support-and-downloads/for-software/acc/supported-cameras-and-encoders/

B. Description: Optical-quality coated optics, designed specifically for video surveillance applications, and matched to specified camera. Provide color-corrected lenses with color cameras.

1. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
2. Fixed Lenses: With calibrated focus ring.
3. Zoom Lenses: Motorized, remote-controlled units, rated as "quiet operating." Features include the following:

a. Electrical Leads: Filtered to minimize video signal interference.
b. Motor Speed: Variable.
c. Lens shall be available with preset positioning capability to recall the position of specific scenes.

2.6 POWER SUPPLIES

A. Power Supplies: Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, type as recommended by camera and lens manufacturer.

1. Enclosure: NEMA 250, Type 3.

2.7 CAMERA-SUPPORTING EQUIPMENT

A. Acceptable Manufacturers:

http://avigilon.com/support-and-downloads/for-software/acc/supported-cameras-and-encoders/

B. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

C. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action and equipped with matching mounting brackets.

1. Scanning Operation: Silent, smooth, and positive.
2. Stops: Adjustable without disassembly, to limit the scanning arc.

D. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation and equipped with matching mounting brackets.

1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
3. Speed: 12 degrees per second in both horizontal and vertical planes.
4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
5. Built-in encoders or potentiometers for position feedback.
6. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.

E. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

2.8 MONITORS

A. Color:

1. Screen Size (Diagonal Dimension): minimum 24”.
2. Resolution Minimum 1920 x 1080 pixels at 60 Hz
3. Aspect ratio 16:9Minimum 2 USB ports
4. HDMI connector
5. Electrical: 120-V ac, 60 Hz.

2.9 DIGITAL VIDEO STORAGE

A. Video Appliance Platform – Technology:

1. Must connect to St. Luke’s Avigilon Platform and include the needed licensing

    a. Provide Primary and Failover Server License for each Camera.

B. Video Appliance Platform:

1. The video appliance platform server component shall feature at the minimum requirements set by the manufacture for the latest version of the Avigilon Control Center

    a. http://avigilon.com/support-and-downloads/for-software/acc/system-requirements/

C. Video Surveillance Platform Performance:

1. Base Performance configurations shall meet the Avigilon manufacturer’s recommendations.

    a. http://avigilon.com/support-and-downloads/for-software/acc/system-requirements/

D. Connectivity: The video appliance platform shall provide support of 1GbE (1 Gigabit Ethernet IP Network) or optional 10GbE (10 Gigabit Ethernet IP Network) infrastructures.

E. System Architecture:

1. The video appliance platform shall support physical footprints in standard 19” rack mounting.
2. Video appliance systems shall be no more than 1U in form factor.
3. Each base system shall be capable of supporting multiple 1GbE or 10GbE connections.

F. Environmental Requirements and Certifications:

1. The video appliance platform shall operate within standard environmental conditions common for physical security systems, including security operations centers, command centers, wiring closets, and similar environments.
2. Operating temperature range shall be 10 to 35°C (50 to 104°F).
3. Operating humidity range shall be 8% to 90% non-condensing.
4. Standard equipment certifications shall be applicable to the video appliance platform, including RoHS compliant 5/6, UL (USA), CUL (Canada), TUV (Germany) EN 6095/IEC 60950 Compliant, CB Report, CCC Certification.

G. Warranty and Support:

1. All video appliance platforms and components shall be supported through a comprehensive three-year manufacturer’s hardware warranty for the appliance. VMS systems are covered separately by their manufacturer’s warranty.
2. Coverage shall include telephone, web and email access to technical support, with web reporting and online incident tracking.
3. Coverage shall include next business day spares replacement.
4. Available upgrades shall include extended coverage, same day advanced spare replacement, and onsite assistance options.

2.10 SIGNAL TRANSMISSION COMPONENTS

A. Cable: Category 6

B. Video Surveillance Category 6 Cable Connectors.

PART 3 - EXECUTION

3.1 WIRING

A. Wiring Method: Install cables in raceways and as otherwise indicated. Conceal raceways and wiring except in unfinished spaces.

B. Wiring Method: Install cables concealed in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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.

E. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.2 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch-minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations, unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system component enclosures, and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections at only the control station.

G. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification".

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.

B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

C. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video surveillance equipment for acceptance and operational testing as follows:

1. Prepare equipment list described in Part 1 "Submittals" Article.
2. Verify operation of auto-iris lenses.
3. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
4. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
5. Set and name all preset positions; consult Owner's personnel.
6. Set sensitivity of motion detection.
7. Connect and verify responses to alarms.
8. Verify operation of control-station equipment.

D. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

E. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

F. Remove and replace malfunctioning items and retest as specified above.

G. Record test results for each piece of equipment.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions and to optimize performance of the installed equipment. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner' utilization of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.5 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video surveillance equipment.

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
3. Review equipment list and data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."
4. Conduct a minimum of six (6) hours' training as specified in instructions to Owner's employees in Division 1 Section "Closeout Procedures."

END OF SECTION

SECTION 28 31 00

FIRE ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fire alarm systems.

B. Related Sections include the following:

1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.
2. Division 21 Section “Fire Protection.
3. Division 23 Section “Temperature Control System”.
4. Division 26 Section “Basic Electrical Materials and Methods”.
5. Division 26 Section “Wiring Methods.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

1. System shall interface with existing Simplex fire alarm system.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Premises protection includes all buildings including tunnels.

C. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Verified automatic alarm operation of smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire extinguishing system operation.
7. Fire standpipe system.
8. Pre-action fire extinguishing system operation.

D. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Release fire and smoke doors held open by magnetic door holders.
7. Activate voice/alarm communication system.
8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
9. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
10. Record events in the system memory.
11. Record events by the system printer.

E. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.

F. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

G. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire alarm system design.
b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
3. Device Address List: Coordinate with final system programming.
4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
6. Batteries: Size calculations.
7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

G. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.

a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
b. Electronic media may be provided to Architect and authorities having jurisdiction.

H. Factory Training: The fire alarm vendor shall include three (3) days of factory training for two (2) individuals. Individuals will be designated by the Owner. Included cost shall cover all travel expenses including airfare, hotel, meals and training. All training materials shall also be included.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Work of this Section be performed by a UL-listed company.

C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level II.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide system shall be provided by SimplexGrinnell LP; a Tyco International Company.

2.2 FIRE ALARM SUB-PANEL

A. Where indicated on plans, provide sub-panel with all of the same features as FACP, specified hereinbefore, except the following:

1. Firefighters' two-way voice communication system comprised of master microphone module, master telephone and remote telephones.

2.3 VOICE EVACUATION SYSTEM

A. Where indicated on the drawings, provide a voice evacuation system integral with the FACP or sub-panel that is a network component of the fire alarm system. Switches shall be provided to

provide all call paging and to selectively page by floor within each building. Microphones, speaker select switches, and amplifiers shall communicate with the fire alarm panel via network cable. The entire system (fire detection and voice evacuation) shall be programmable within one software package that shall be provided to the Owner. Features shall include:

1. Amplifiers comply with UL 1711 and are sized to supply a minimum of 2.0 watts of power for each connected speaker.
2. Provide tone generator capable of providing a variety of tones.
3. 2-channel to permit transmission of announcements to zones or floors automatically or by use of the central control microphone. All announcements are made over dedicated, supervised communication lines.

2.4 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

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 the FACP.
2. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
3. Station Reset: Key- or wrench-operated switch.
4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Multipurpose type, containing the following:

    a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
    b. Piezoelectric sounder rated at 88 dBA at 10 feet according to UL 464.
    c. Heat sensor, combination rate-of-rise and fixed temperature.

4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of 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 analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

    a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F per minute.
    b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F.
    c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Ionization Smoke Detector:

1. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
2. Detector Sensitivity: Between 0.5 and 1.7 percent/foot smoke obscuration when tested according to UL 268A.

D. Beam-Type Smoke Detector: Each detector shall consist of a separate transmitter and receiver, and shall have the following features:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Adjustable Sensitivity: At least six sensitivity levels, settable at the receiver, measured as percent of obscuration.
3. Two selectable alarm delay settings, allowing each to be associated with a corresponding sensitivity.
4. Trouble signal delay, fixed at 20 seconds.
5. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status.

E. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

    a. Sensor: LED or infrared light source with matching silicon-cell receiver.
    b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

2. Ionization Smoke Detectors:

    a. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
    b. Detector Sensitivity: Between smoke obscuration when tested according to UL 268A.

3. UL 268A listed, operating at 24-V dc, nominal.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
5. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for

mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
7. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
9. Each sensor shall have multiple levels of detection sensitivity.
10. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
11. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate-of-rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.7 NOTIFICATION APPLIANCES

A. Description: 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.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.

C. Visible Alarm Devices: Xenon strobe lights listed under 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. Rated Light Output: 75 candela, unless noted otherwise.
2. Strobe Leads: Factory connected to screw terminals.

2.8 ALARM HORNS

A. Horns to have 85 dBA output at ten (10) feet. Horns to be Wheelock ET70 series.

2.9 ALARM SPEAKERS

A. Speakers shall be designed for high efficiency sound output with field selectable input voltage (25/70 VRMS) and field selectable taps from 1/8 to 2 watts. Strobes shall be multi candela field selectable wall: 15/30/75/110 cd or 135/185 cd. Features shall include high efficiency design for maximum output at minimum wattage across a listed frequency range of 400 to 4000 Hz.

B. The speaker and speaker strobe appliances shall be designed for indoor surface or flush mounting. The speaker and speaker strobe shall incorporate a speaker mounting plate with a grille cover which is secured with two screws for a level, aesthetic finish and shall mount to standard electrical hardware required no additional trimplate or adapter.

C. The finish of the Series E speakers and strobe speakers shall be white, red, or nickel plate.

D. All speaker and speaker strobe appliance shall be backward compatible.

E. Wall speakers shall be Wheelock Series ET70. Ceiling speakers shall be Wheelock Series ET90.

2.10 ALARM STROBES

A. Strobe flash rate to be one flash per second with zero inrush current. In addition strobes are to meet the following conditions:

1. Visual only signals shall provide a wide range of intensities and mounting options for wall or ceiling applications. Strobe intensity shall be multi candela field selectable. Wall: 15/30/75/100 cd or 135/185 cd. Ceiling: 15/30/75/95 cd or 115/177 cd.

B. Synchronized strobes shall be required for any space where more than one strobe is visible from any location and where indicated on drawings. This will include all corridors.

1. When synchronization is required, the strobe portion of the appliance shall be compatible with Wheelock's SM, DSM sync modules or Wheelock's PS-12/24-8MP Power Supply with built-in Patented Sync Protocol. The strobes shall not drift out of synchronization at any time during operation. IF the sync module or Power Supply fails to operate, (i.e., contacts remain closed), the strobe shall revert to a non-synchronized flash rate.

C. Wall mounted strobes shall be Wheelock Series RSS (square).

2.11 COMBINATION SIGNALS

A. Combination Signals: Provide factory-combined audible and visible alarm units of type indicated in a single mounting unit where indicated.

1. Visual/Speaker Device: Wheelock ET70 Series for wall mount, Wheelock ET90 Series for ceiling mount.
2. Visual/Horn Device: Wheelock ET70 Series for wall mount, ceiling mount not used.

    a. Visual/horn and horn only devices shall typically transmit tone upon notifier appliance activation, but shall be capable of delivering live voice messages.

2.12 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires 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.

B. Material and Finish: Match door hardware.

2.13 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.14 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall.

2.15 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet.
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

E. 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.

F. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

H. FACP: Surface mount with tops of cabinets not more than 72 inches above the finished floor.

I. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

    a. Detectors that are outside their marked sensitivity range shall be replaced.

5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of final acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of final acceptance, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Annual Test and Inspection: One year after date of final acceptance, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections and approved by SLHS.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION