DLR Group

Architecture
Engineering
Planning
Interiors

Compton Community College District
Instructional Building #1

1111 East Artesia Boulevard
Compton, California 90221
DLR Group Project No. 75-15238-00

Project Manual – Volume 2

DSA Submittal

July 31, 2017

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SECTION 000107

SEALS PAGE

IDENTIFICATION STAMP
DIV. OF THE STATE ARCHITECT

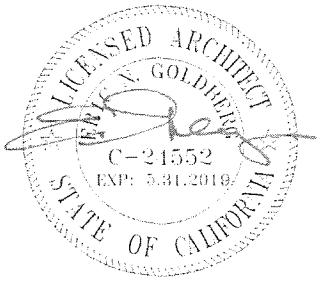
APP 3 117612

AC MF FLS EB SS HN
Date 08-10-2017

PART 1

1.01 DESIGN PROFESSIONALS OF RECORD

A. Architect: DLR Group.
   1. Eric N. Goldberg
   2. C 24552
   3. Responsible for Divisions 01-49 Sections except where indicated as prepared by other design professionals of record.

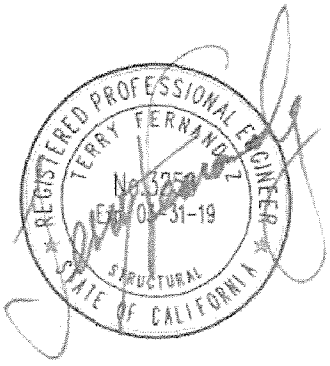


B. Civil Engineer: Brandow & Johnston, Inc
   1. Orlando Moreno, PE
   2. C 65405
   3. Responsible for Sections 015723, 024113, and Divisions 31, 32 and 33 except where indicated as prepared by other design professionals of record.

FOR BRANDOW & JOHNSTON, INC

C. Landscape Architect: Landshapes.
   1. Cynthia Lee
   2. 2524
   3. Responsible for Sections 320190, 328000, and 329000.

D. Structural Engineer: MHP.
   1. Terry Fernandez
   2. 3256
   3. Responsible for Sections 033000, 051200, 053100, and 054000.



E. Plumbing Engineer: DLR Group.
   1. Tanase Cocea
   2. M 34223
   3. Responsible for Division 22

F. HVAC Engineer: DLR Group.
   1. Tanase Cocea
   2. M 34223
   3. Responsible for Division 23

G. Electrical Engineer: DLR Group.
   1. Zoheir Guemmat
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H. Communications: Plan Net.
   1. Carlo A Monton
   2. 171805R
   3. Responsible for Division 27

I. Fire Protection: AV Fire Protection Engineering, Inc.
   1. Vicky Avitan
   2. FP 1494
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END OF DOCUMENT

SECTION 000107

SEALS PAGE

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LOS ANGELES BASIN REGIONAL OFFICE
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APPL NO. 03-117612 DATE 4-13-18
REVISION A

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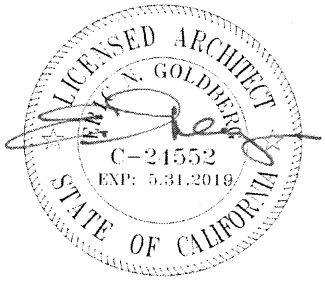

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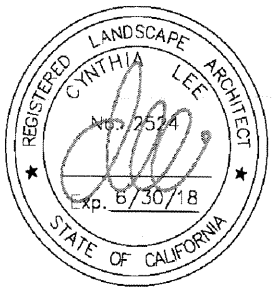

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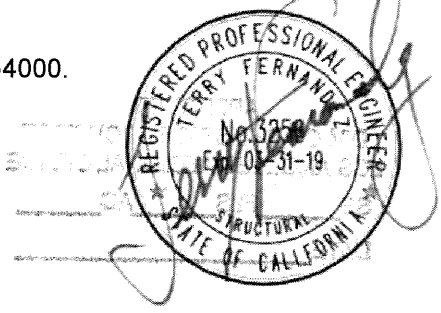

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SS FLS AC
DATE 5/25/2018

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SS 81 FLS FC AC MF
DATE 5/25/2018
FOR REVISION (C)

G. Electrical Engineer: DLR Group.
   1. Stephen Bakin
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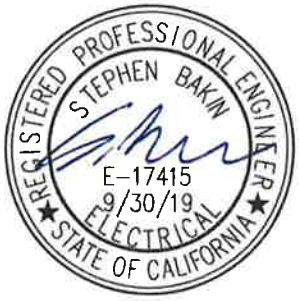

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PROJECT MANUAL INCLUDING SPECIFICATIONS

FOR

Compton Community College District
Instructional Building #1

DOCUMENT 000110

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PART 1 GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this Section

B. Section Includes:
   1. Furnish and Install an Automatic Fire Sprinkler System as shown in the Contract Documents.

C. Approval Submittal Procedure:
   1. Provide Approval Submittals including Product Data for the Automatic Wet Pipe Fire Sprinkler System, in compliance with DSA requirements of the "Fire and Life-Safety Plan Review Submittal Guideline for Automatic Fire Sprinkler Systems" (AFSS).

D. Manufacturer's Data:
   1. Submit complete and detailed equipment and material list of items to be furnished and installed under this Section.

E. Regulatory Requirements:
   1. Installation of the fire sprinkler system shall be per the Approved Drawings having been stamped "Approved" by DSA.
   2. Approval by DSA may include minimum code requirements and does not supersede more extensive requirements of the Contract Documents.

F. Closeout Submittals-Contract closeout as specified herein:
   1. Record Drawings:
      a. Record drawings of installed Work shall be maintained current on the project site and available for the Fire Inspector and the IOR to review.
      b. At completion of installation, submit to the Architect of Record, drawings signed by the installing Contractor and Record Drawings in AutoCAD format.
   2. Record Specifications.
   3. Record Product Data: Include specific model, type, and size for all equipment and material installed.
   4. Record Samples
   5. Maintenance Manuals

1.02 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the Work of this Section and are hereby incorporated into and made a part of the Contract Documents.
   1. NFPA 13, 2013 Standard for the Installation of Sprinkler Systems.
   3. California Fire Code 2013
   4. California Building Code 2013

1.03 QUALITY ASSURANCE

A. Comply with all applicable national or local codes and standards.

B. Except where exceeded by the requirements of these specifications, the following are made part of this section: Approved prints and details and all provisions of the NFPA 13 Standard for Installation of Sprinkler Systems, Hose Systems, and NFPA 24 Standard of the Installation of Private Fire Service mains and Their Appurtenances.

C. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a five year history of successful production that is acceptable to the Architect.

D. Qualifications of installer: Installer shall have a current C-16 license in the state of California for the installation of fire sprinkler systems.

1.05 COORDINATION

A. The automatic fire sprinkler contractor shall coordinate the installation of the automatic fire sprinkler system with all other trades prior to the installation of the system.

1.06 JOB CONDITIONS

A. Unscheduled utility flow interruptions are not permitted. Schedule all service interruptions in advance with the OAR.

1.07 EXTRA MATERIALS FOR MAINTENANCE

A. Provide spare sprinkler heads in a quantity equal to two percent (2%) of the total number of each type of sprinkler head installed. There shall be no less than two (2) heads of each type and temperature rating provided and in no case less than six (6) spare sprinkler heads per building. There shall be no fewer than six (6) spare sprinkler heads for up to 300 sprinkler heads installed; no less than 24 sprinkler heads shall be kept inside of spare head box (es). A spare sprinkler wrench for each type of sprinkler head shall also be provided inside of each spare sprinkler head box at each building. Locations of spare sprinkler boxes shall be located at:
   1. Fire Sprinkler Riser when enclosed and secure.

1.08 ADDITIONAL WORK

A. Prior to the award of the Automatic Fire sprinkler System Contract, the contract shall provide the owner with unit pricing and/or allowances for additional work that may be required beyond the scope of the work shown on the contract documents to meet NFPA and CBC requirements.

PART 2 PRODUCTS

2.01 FIRE PROTECTION SYSTEM DESCRIPTION

A. General: provide complete systems including, but not limited to:
   1. Provide complete overhead Automatic Fire Sprinkler System with sprinklers installed as required according to type, location, and temperature rating indicated on the Contract Documents.

B. Sprinkler Heads:

1. Provide concealed pendant type sprinkler heads in areas with no supervision.
2. Provide upright sprinklers with brass finish in areas with exposed piping.
3. Provide semi-recessed corrosion resistant glass bulb type sprinklers in other areas.
4. Sprinkler shall be glass bulb type, with hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.
5. Sprinklers in exterior locations and any other areas which will experience over 100 degrees F ambient temperature shall be furnished with 200 to 225 degree rated sprinklers. Sprinkler heads in boiler rooms, furnace rooms, or heater rooms shall be furnished with sprinklers rated at 250 to 290 degrees F. If a sprinkler is directly affected by a spotlight, steam, or other heat source, a 350 degree F or higher sprinkler head shall be furnished. Sprinkler heads in all other locations unless otherwise noted, shall be 155 to 165 degrees F rated.
6. Automatic fire sprinkler head types shall be as follows:
   a. In areas with ceiling heights of 9'-0" or lower, sprinkler heads installed shall be recessed or fully concealed.
   b. Ceilings 8'-0" or lower shall be provided with fully concealed sprinkler heads.
   c. Areas with ceiling height of 9'-0" or lower that are not constantly supervised such as corridors, arcades, and restrooms shall be provided with fully concealed sprinkler heads.
7. Sprinklers in light hazard occupancies are required to be Quick response sprinklers as required in NFPA 13. Sprinkles shall be of the same manufacturer throughout the building as indicated. Sprinklers shall typically be ½ inches NPT, standard orifice, minimum 5.6 nominal K factor, UL listed for 175 psi and listed for light and ordinary hazard occupancies.
8. . Sprinklers location shall be design and installed in an aesthetically pleasing manner and should generally be located in the center 0f 24"X24" ceiling tiles and in the center of 24"x48" ceiling tiles in the 24" direction and 12" from the edge in the 48" direction.
10. UL/FM listed sprinkler head guards shall be provided on sprinkler heads installed at 7'-6" above floor or lower in exposed locations or that are deemed subject to damage. Sprinkles guards shall be securely fastened with a bolt-on feature to the base of the sprinkler or be a factor installed guard. Guards shall also be provided on upright and sidewall heads where sprinklers are installed at 7'-6" heights or lower.
11. Sprinklers installed in suspended ceiling shall comply with DSA IR25-2.13 & 3.13.

C. Fire Sprinkler and Standpipe Systems:
1. Fire Department Connection (FDC) with check valve (wafer type) shall be provided after the backflow preventer and before the building fire sprinkler riser(s) located where the FDC will be accessible to the fire department from the street or sidewalk without obstructions. No shut off valve shall be allowed on the FDC line as per NFPA 13. FDCs shall have a height between 2'-0" and 4'-0" above the ground.
3. PIVs shall be electrically supervised regardless of the number of the fire sprinklers served (CBC 903.4) and set a height of 3'-0" to the top and have the handle locked in place with a break-a-way lock.
4. Provide check valves, shut-off valves, drain valves, ITV, and flow indicator at the locations required. (Test-and- drain combination valves are prohibited).
5. Flow indicator shall activate the fire alarm system between 45 and 90 seconds and activate a local alarm on the outside of the building continuously with water flow. All shut-off including valves on the fire main backflow preventer shall be electrically supervised according to CBC 903.4 and NFPA 13.

6. Pipe through ceilings at head locations shall be furnished with a two piece or fully concealed escutcheon. Unless otherwise designated, escutcheons shall be identical and match the others escutcheons of the same type throughout the building or site. Piping though walls and ceilings shall have a split ring chrome escutcheon.
7. Furnish and install all required signs, spare heads, special wrenches, and spare sprinkler head boxes as required to satisfy NFPA 13 and this Specification.
8. Sprinkler system piping shall be provided with complete drainage as required by NFPA 13. Inspector's test valve discharge shall be piped away from planters to asphalt areas or to a hub drain connected to a sanitary or storm drain system. Furnish protection of piping against accidental or malicious damage.
9. Upon completion of the Work of this Section before Substantial Completion, subject system, including undergrounds supply connection to tests is required. A minimum hydrostatic test shall be two hundred pounds (200 psi) or fifty pounds (50 psi) in excess of the maximum system working pressure, whichever is greater for two hours with no leaks or loss of pressure per NFPA 13. The IOR shall be furnished with a NFPA 13 test certification.
10. Local fire sprinkler alarm requirements shall be accomplished with a vane or paddle type water flow detector switch and an electrically powered fire sprinkler horn located on the street side of the building and connected to the fire alarm control panel with secondary power provided from the fire alarm batteries. The drilled out disk shall be attached to the mounting U-bolt. Time delay shall be set at 45 to 60 seconds. Mechanically activated water bells with alarm valves and pressure switches are prohibited.
11. Seismic separation assemblies shall be located between the buildings is space allows accessibility. Otherwise, they shall be located inside the building providing the most space. Swing joints may be fabricated on site using flexible groove couplings and six (6) grooved 90 degree elbows (see NFPA 13, figure A.9.3.3 (a)). Seismic separation assemblies can also be made utilizing a manufactured, UL/FM listed seismic joint assembly rated at a minimum of 175 psi.
12. Hanging, bracing, and support shall utilize only UL/FM listed approved products and comply with NFPA 13, Chapter 9 requirements for rod and bolt sizes. Hanger rods in exterior locations and in parking structures shall have Electrodeposited Zinc Coating per ASTM B633 to prevent rusting.
13. Building fire sprinkler riser assemblies shall be provided as follows:
    a. Every building shall be provided with an accessible and electrically supervised riser shut off valve at a height not to exceed 5'-0" above the floor.
    b. Every building riser assembly shall be equipped with a check valve followed by a main drain valve and then the flow indicating switch and pressure gauge immediately after the shut-off valve.
    c. In cases where a riser assembly is provided for each floor in the building, a check valve, main drain and flow switch shall be provided for each floor; the main building shut-off shall not be required.
    d. An electrically supervised Post Indicator Valve located outside the building may serve as the building riser shut-off valve.
14. Pipe joints shall not be located below building foundation footings or slabs on grade. Single piece riser assemblies shall be utilized.

2.02 MATERIALS

A. Access Panel:
FAP-1 Square, steel, prime coated with vandal-proof door lock operated by an Allen wrench

B. Globe or Angel Valves: UL/FM listed:
AV-1 Bronze angle valve: two inches and smaller, screwed in bonnet, threaded ends, rising stem.

C. Automatic Fire Sprinkler Head, UL/FM listed:
AFSH-1 Brass pendant type for areas without ceilings
AFSH-2 Brass upright type for areas without ceilings
AFSH-3 Chrome or poly-coated, semi-recessed type with semi- recessed escutcheon
AFSH-4 Fully concealed type sprinklers; chrome or factory painted cover

D. E.Gear operated Butterfly Valves:
GOBFV – 1 Grooved end Gear Operated Butterfly Valve, 300 psi, for fire protection sprinkler risers. UL listed, FM approved, with weatherproof gearbox and double pole/double throw monitor switch, double seal design for bubble tight shut off at 175 psi. Corrosion-resistant, fusion-bonded Nylon II body coating, easy to read position indicator
GOBFV-2 Wafer Type Gear Operated, Butterfly Valve same requirements as GOBFV-1

F. Check Valves:
CV-1 Bronze check valves: Two (2) inches and smaller, 200 psi WOG, bronze disc swing type, conforming to MSS-SP—80-97, threaded ends.
CV-2 Iron check valves: 2-1/2" and larger, Class 175, composition disc, swing type, bolted cap, UL listed, FM approved flanged ends
CV-3 Water Type Check Valve
CV-4 Grooved Check Valve 2-1/2" and larger

G. Sprinkler Escutcheons:
SE-1 Concealed sprinklers shall have a low profile (flat) cover plate that is listed for use with the sprinkler to which it is installed. Cover plates shall be factory painted or plated with a finish or color approved by the Architect.
SE-2 Recessed sprinkler shall have low profile two piece escutcheons that are listed for use with the sprinkler to which it is installed. Escutcheons shall be factory painted or plated with a finish and color approved by the Architect.

H. Fire Department Connections:
FDC-1 UL listed or FM approved, wall mounted 4"X2- 1/2" X 2-1/2" bronze body Fire Department House Connection (FDC). Potter Roemer Model 5021 thru 5027.

I. Flow Indicators:
FIA-1 Listed by State Fire Marshall with a double pole, double-throw switch, one normally closed, UL listed and FM approved.

J. Outside Stem and Yoke Gate Valves:
OS&Y-1 Bronze Gate Valves: Two (2) inches and smaller, Class 175, solid bronze wedge disc, OS&Y copper silicon alloy stem, UL/FM listed, threaded ends

OS&Y-2 Iron gate valves: 2-1/2" and larger, Class 175, IBBM, OS&Y, solid wedge disc, Teflon-impregnated packing UL/FM listed, flanged ends

OS&Y-3 2-1/2 inches and larger, epoxy coated, resilient wedge, 175 lbs. gate valve (for riser valves, PIV and shut-off)

K. Gate Valves:

GV-1 Bronze gate valves: Two (2) inches and smaller, class 175, solid bronze wedge disc, rising stem copper silicon alloy stem, UL/FM listed, threaded ends.

GV-2 Iron gate valves: 2-1/2 inches and larger, class 175, IBBM, solid wedge disc, Teflon impregnated packing, UL/FM listed, flanged ends.

L. Gear Operated Ball Valves:

GOBV-1 Threaded ball valve for sizes two (2) inches and smaller

M. Seismic Swing Joints:

SJ-1 UL/FM approved flexible seismic connector with grooved or threaded ends for seismic separation requirements.

SJ-2 Fabricated swing joint as per NFPA 13 using six groove 90 degree elbows and flexible groove couplings

N. Post Indicator Valves:

PIV-1 Vertical Indicator Posts: Furnished for underground valves, post must provide a means of knowing if the valve is open or shut, UL/FM listed. (Where a backflow assembly is provided, the shutoff valves on the backflow preventer must satisfy the requirement for a Post Indicator Valve to control the fire main and FDC).

O. Sprinkler Guards:

SPG-1 Sprinklers installed at 7'-6" above floor or lower in exposed locations or that are deemed subject to damage shall be equipped with a UL/FM listed, head guard. Guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer. Sprinkler head guards shall be securely fastened with a bolt-on feature to the base of the sprinkler or be a factory installed guard. Guards shall also be provided on upright and sidewall heads where sprinklers are installed at 7'-6" heights or lower.

P. Sprinkler Alarm bell:

SAB-1 UL/FM approved, surface-mounted, weatherproof and red finished.

Q. Hangers, Supports, Bracing:

HSB-1 Afcon products or UL listed or FM approved equal

R. Threaded Fittings:

TF-1 Ductile iron, 300 psi rated, UL listed, FM approved and/or NFPA approved.

TF-2 Cast iron fittings, 175 psi rated, UL listed, FM approved and/or NFPA approved

TF-3 Malleable iron, 300 psi rated, UL listed, FM approved and/or NFPA approved.

TF-4 Galvanized, 175 psi, UL listed, FM approved and/or NFPA approved

S. Fire Sprinkler Pipes:

FSP-1 Fire Sprinkler Pipe: 1" through 8" Schedule 40 black and/or galvanized steel, meeting ASTM Standards A53, A135 and/or A795. Pipe Corrosion Resistance Ratio (CRR) shall be 1.00 or greater. Pipe may be threaded or grooved.

a. Piping two (2) inches and smaller shall have threaded joints and fittings in all concealed, non-accessible locations. Groove coupler connections (Victaulic or equal) on pipe sizes one (1) inch through two (2) inches are acceptable in all accessible areas. Plain end connections such as "plainlock" and "FIT" are prohibited.
b. For pipe size 2-1/2 inches and larger, grooved type welded, threaded and flanged connections may be used. Any connection that does not utilize a threaded, welded or grooved connection is prohibited.
c. Submit verification form the manufacturer stating that piping material furnished meets above criteria; (i.e., threadable pipe has a UL assigned CRR of 1.00 minimum that it meets ASTM A53, A135, or A795 and is UL listed, FM approved and/or NFPA approved.

2.03 ACCESSORIES AND APPURTENANCES

A. Escutcheons: Polished chrome plated, split-ring type for exposed piping at every penetration inside finished rooms.

B. Guards: provide fire sprinkler with guards as required in 7'-6" ceilings and where required by the Architect.

C. Miscellaneous: Provide all other accessories and appurtenances required for a complete system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which the Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove all burrs. Thread bevel for welding or groove all plain end ferrous pipe ends.

B. Remove scale and foreign matter from inside and outside of the pipes before assembly.

C. Provide piping connections to equipment with flanged or grooved connections.

3.03 INSTALLATION

A. Install underground supply line connected to detector check or water main indicated. Braced or clamped bends shall be in accordance with requirements of NFPA 24. Furnish concrete thrust blocks where required. Tracer wire shall be installed to assist in the location of all PVC underground piping.

B. Install FDCs, check valves, shut-off valves, gauges, inspector test and drain assemblies and water flow switches as per DSA Approved Drawings. FDC must be installed so that it is unobstructed and accessible for the Fire Department's first response unit.

C. Pipe through floors, wall, and ceilings at head locations shall be furnished with required sleeves and escutcheons and fire caulking where indicated and/or required by Code.

Escutcheons shall be polished chrome plated unless another finish is selected by the Architect.

D. Sprinkler System shall be provided with complete drainage facilities in accordance with CBC standards. Drain discharge may discharge into a sewer, storm drain, sump pit or street gutter. Fire sprinkler drains shall not discharge onto landscaping or across a sidewall. Discharge may be to a hub drain designed to receive a full flow of water from a fire sprinkler drain valve under working pressure.

E. Upon completion of the Work of this Section and before substantial completion, subject the entire system including underground supply connections to tests as required by NFPA 13 and CBC standards and furnish the Owner with a Certificate of Compliance as required.

F. Close nipples are prohibited. Threaded unions are prohibited. A groove type fitting shall be used in lieu of a threaded union. If a groove style coupling is used in a concealed area, an access panel allowing full access to that connection shall be provided.

G. Fire sprinkler systems, piping hangers, seismic bracing, anchors and supports shall conform to all NFPA 13, CBC and all other applicable codes and the requirements of this Specification.

H. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for intended service and shall be molded and produced by the coupling manufacturer.

I. Tee branch outlets on fire sprinkler mains shall be by the use of a threaded ductile iron tee fitting, a groove type tee fitting, or by the use of a thread-a-let welded on by a certified welder as required by NFPA 13. Mechanical tee bolted branch outlet fittings are prohibited except for branch outlet sizes two (2) inches and smaller. "Hooker" type mechanical tees shall not be used.

J. Sprinkler lines within the building shall be concealed within the structure. Risers shall be installed in utility, supply rooms, or similar service areas whenever possible and shall not obstruct access or maintenance of other equipment within the space. Mains and risers shall be located within the area protected by the sprinkler system unless otherwise approved by fire authorities having jurisdiction.

K. Sprinklers hat have been dropped, damaged, have cracked bulbs, or show a visible loss of fluid shall not be installed.

L. Sprinkler bulb protectors shall be removed by hand after sprinkler installation. Tools or any other device to remove the protector that could damage the bulb in any way shall not be used.

M. Routing of piping in non-concealed exposed areas shall be subject to the Architect's approval.

N. Provide shunt trip when sprinklers are installed in the elevator machine rooms and elevator hoist way unless the sprinklers are located two (2) feet from the hoist way pit floor.

O. Inspectors test valve (ITV) shall be located at the opposite end of the sprinkler system from the supply. Test-and drain type combination valves are prohibited. ITV discharge and main

drain lines shall be piped to a sump pit to the outside of the building to within a foot from the ground where it will drain away from the building to an exterior storm drain.

3.04 PROTECTION

A. Protect the Work of this Section until substantial completion.

3.05 CLEAN-UP

A. Remove rubbish, debris, and waste materials and legally dispose at off-project site.

END OF SECTION

SECTION 220513 - 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 NEMA MG 1 unless otherwise indicated.

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

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

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

2.3 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

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

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

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

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

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

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

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

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. 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.

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 220513

SECTION 220517 - SLEEVES AND SLEEVE SEALS 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. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Stack-sleeve fittings in this article can be used in concrete floor and roof slabs, but are without seepage holes; therefore, they cannot be used as replacements for floor drains. Using grout, fill the annular space between fitting and slab opening. These fittings are available in NPS 1-1/2 to NPS 12 (DN 40 to DN 300).

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

1. Smith, Jay R. Mfg. Co.
2. Zurn Industries, LLC.

C. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Sleeve-seal systems in this article are used for piping penetrations in slabs-on-grade and below grade in exterior walls. These systems are available for NPS 1/2 to NPS 48 (DN 15 to DN 1200) piping.

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

C. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping 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.

2.4 SLEEVE-SEAL FITTINGS

A. Sleeve-seal fittings in this article are used for piping penetrations in slabs-on-grade and in exterior walls. These fittings are made to match piping OD, so they must be selected to match the penetrating piping size. They are available for NPS 1/2 to NPS 6 (DN 15 to DN 150) piping.

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

1. HOLDRITE.

C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves.
b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

    a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS 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. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

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

2.2 FLOOR PLATES

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall 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, cast-brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

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

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

1. New Piping: One-piece, floor-plate type.

E. Install clean out escutcheon plates level and in line with others in line of site.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES 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. Filled-system thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

B. Related Sections:
1. Section 221113 "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
2. Section 221116 "Domestic Water Piping" for water meters inside the building.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

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

    a. Ashcroft Inc.
    b. Marsh Bellofram.
    c. Miljoco Corporation.
    d. Palmer Wahl Instrumentation Group.
    e. REOTEMP Instrument Corporation.
    f. Trerice, H. O. Co.
    g. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.

6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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

    a. Ashcroft Inc.
    b. Flo Fab inc.
    c. Miljoco Corporation.
    d. REOTEMP Instrument Corporation.
    e. Watts; a Watts Water Technologies company.
    f. Weiss Instruments, Inc.
    g. Weksler Glass Thermometer Corp.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of Grade C, plus or minus 3 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

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

1. Flow Design, Inc.
2. Miljoco Corporation.
3. Watts; a Watts Water Technologies company.
4. Weiss Instruments, Inc.
5. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

F. Core Inserts: Chlorosulfonated polyethylene synthetic self-sealing rubber.

2.6 TEST-PLUG KITS

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

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Watts; a Watts Water Technologies company.
5. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.7 SIGHT FLOW INDICATORS

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

1. ARCHON Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Rosemount Division.
4. Ernst Flow Industries.
5. John C. Ernst Co., Inc.
6. Pentair Valves & Controls; Penberthy Brand.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig (860 kPa).

E. Minimum Temperature Rating: 200 deg F (93 deg C).

F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Liquid-filled bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Compact-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

B. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C).

C. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F (0 to plus 115 deg C).

D. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).

E. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C).

F. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C).

G. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

H. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C).

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa).

B. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1100 kPa).

C. Scale Range for Water Service Piping: 0 to 200 psi (0 to 1400 kPa).

D. Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa).

E. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1100 kPa).

F. Scale Range for Domestic Water Piping: 0 to 200 psi (0 to 1400 kPa).

G. Scale Range for Domestic Water Piping: 0 to 300 psi (0 to 2500 kPa).

END OF SECTION 220519

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Steel ball valves.
4. Iron ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

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

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

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 (DN 100) and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4 (DN 100).

H. Valves in Insulated Piping:

1. Include 2-inch (50-mm) stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

A. One-Piece, Brass Ball Valves:

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

    a. KITZ Corporation.

2. Description:

    a. Standard: MSS SP-110.
    b. CWP Rating: 400 psig (2760 kPa).
    c. Body Design: One piece.
    d. Body Material: Forged brass or bronze.
    e. Ends: Threaded and soldered.
    f. Seats: PTFE.
    g. Stem: Brass or stainless steel.
    h. Ball: Chrome-plated brass or stainless steel.
    i. Port: Reduced.

B. Two-Piece, Brass Ball Valves with Full Port and Brass Trim:

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

    a. American Valve, Inc.
    b. Crane; Crane Energy Flow Solutions.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Watts; a Watts Water Technologies company.

2. Description:

    a. Standard: MSS SP-110.
    b. CWP Rating: 600 psig (4140 kPa).
    c. Body Design: Two piece.
    d. Body Material: Forged brass.
    e. Ends: Threaded and soldered.
    f. Seats: PTFE.
    g. Stem: Brass.
    h. Ball: Chrome-plated brass.
    i. Port: Full.

C. Three-Piece, Brass Ball Valves with Full Port and Brass Trim:

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

    a. Jomar Valve.
    b. KITZ Corporation.
    c. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Three piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

2.3 BRONZE BALL VALVES

A. One-Piece, Bronze Ball Valves with Bronze Trim:

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

a. Conbraco Industries, Inc.
b. NIBCO INC.
c. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig (2760 kPa).
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

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

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

a. Crane; Crane Energy Flow Solutions.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Watts; a Watts Water Technologies company.
e. Zurn Industries, LLC.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.

e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

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

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

a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Regular.

D. Three-Piece, Bronze Ball Valves with Full Port and Bronze or Brass Trim:

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

a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Three piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

E. Three-Piece, Bronze Ball Valves with Regular Port and Bronze Trim:

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

    a. Conbraco Industries, Inc.
    b. Jamesbury; Metso.
    c. NIBCO INC.
2. Description:

    a. Standard: MSS SP-110.
    b. CWP Rating: 600 psig (4140 kPa).
    c. Body Design: Three piece
    d. Body Material: Bronze
    e. Ends: Threaded or soldered.
    f. Seats: PTFE.
    g. Stem: Bronze.
    h. Ball: Chrome-plated brass.
    i. Port: Regular.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) 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 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.4 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. One piece, brass ball valve.
3. One piece, bronze ball valve with bronze trim.
4. Two-piece, brass ball valves with full port and brass trim.
5. Two-piece, bronze ball valves with full port and bronze or brass trim.
6. Three-piece, brass ball valves with full port and brass trim.
7. Three-piece, bronze ball valves with full port and bronze or brass trim.
8. Two-piece, bronze ball valves with regular port and bronze trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Class 150, steel ball valves with full port.
3. Class 150, iron ball valves.

3.5 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. One piece, brass ball valve.
3. One piece, bronze ball valve with bronze trim.
4. Two-piece, brass ball valves with full port and brass trim.
5. Two-piece, bronze ball valves with full port and bronze or brass trim.
6. Three-piece, brass ball valves with full port and brass trim.
7. Three-piece, bronze ball valves with full port and bronze or brass trim.
8. Two-piece, bronze ball valves with regular port and bronze trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Class 150, steel ball valves with full port.
3. Class 150, iron ball valves.

3.6 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. One piece, brass ball valve.
3. One piece, bronze ball valve with bronze trim.
4. Two-piece, brass ball valves with full port and brass trim.
5. Two-piece, bronze ball valves with full port and bronze or brass trim.
6. Three-piece, brass ball valves with full port and brass trim.
7. Three-piece, bronze ball valves with full port and bronze or brass trim.
8. Two-piece, bronze ball valves with regular port and bronze trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Class 150, steel ball valves with full port.
3. Class 150, iron ball valves.

END OF SECTION 220523.12

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze lift check valves.
2. Bronze swing check valves.
3. Iron swing check valves.
4. Iron swing check valves with closure control.
5. Iron, grooved-end swing check valves.
6. Iron, center-guided check valves.
7. Iron, plate-type check valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

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

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

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

2.2 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

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

a. Crane; Crane Energy Flow Solutions.

b. Jenkins Valves; Crane Energy Flow Solutions.
c. Stockham; Crane Energy Flow Solutions.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

B. Class 125, Lift Check Valves with Nonmetallic Disc:

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

a. Flo Fab inc.
b. KITZ Corporation.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: NBR, PTFE.

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze, Swing Check Valves with Bronze Disc:

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

a. American Valve, Inc.
b. Crane; Crane Energy Flow Solutions.
c. Jenkins Valves; Crane Energy Flow Solutions.
d. KITZ Corporation.
e. NIBCO INC.
f. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.
g. Disc: PTFE.

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

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

a. American Valve, Inc.
b. Crane; Crane Energy Flow Solutions.
c. Jenkins Valves; Crane Energy Flow Solutions.
d. KITZ Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

2.4 IRON SWING CHECK VALVES

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

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

a. Crane; Crane Energy Flow Solutions.
b. Jenkins Valves; Crane Energy Flow Solutions.
c. KITZ Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.

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

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

   a. Crane; Crane Energy Flow Solutions.
   b. Jenkins Valves; Crane Energy Flow Solutions.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Watts; a Watts Water Technologies company.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 500 psig (3450 kPa).
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged or threaded. See valve schedule articles.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.

2.5 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

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

   a. Crane; Crane Energy Flow Solutions.
   b. Jenkins Valves; Crane Energy Flow Solutions.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Watts; a Watts Water Technologies company.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged or threaded. See valve schedule articles.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed exterior lever and weight.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

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

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

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Pump-Discharge Check Valves:

a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat check valves.
c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged.
7. For Grooved-End Copper Tubing and Steel Piping: Grooved.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG (1035 kPa) OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only: Bronze lift check valves, Class 125, bronze disc with soldered end connections.
2. Horizontal and Vertical Applications: Bronze swing check valves, Class 125, bronze disc with soldered end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron swing check valves, Class 125, metal seats with threaded or flanged end connections.
2. Iron, grooved-end swing check valves, 300 CWP.
3. Iron, dual-plate check valves, Class 125, metal seat with threaded or flanged end connections.
4. Iron, single-plate check valves, Class 125, resilient seat with threaded or flanged end connections.

3.6 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG (1035 TO 1380 kPa))

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only: Bronze lift check valves, Class 125, bronze disc with soldered or threaded end connections.
2. Horizontal and Vertical Applications: Bronze swing check valves, Class 125, bronze disc with soldered or threaded end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron swing check valves, Class 125, metal seats with threaded or flanged end connections.
2. Iron, grooved-end swing check valves, 300 CWP with threaded or flanged end connections.
3. Iron, dual-plate check valves, Class 125, metal seat with threaded or flanged end connections.
4. Iron, single-plate check valves, Class 125, resilient seat with threaded or flanged end connections.

3.7 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Bronze swing check valves, Class 125, bronze disc with soldered or threaded end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron swing check valves, Class 125, metal seats with threaded or flanged end connections.
2. Iron swing check valves with closure control, Class 125, lever and spring with threaded or flanged end connections.
3. Iron, grooved-end swing check valves, 300 CWP.
4. Iron, center-guided check valves, Class 125, compact wafer.
5. Iron, center-guided check valves, Class 125, globe, seat with threaded or flanged end connections.
6. Iron, dual-plate check valves, Class 125, metal seat with threaded or flanged end connections.
7. Iron, single-plate check valves, Class 125, resilient seat with threaded or flanged end connections.

END OF SECTION 220523.14

SECTION 220523.15 - GATE 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 gate valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 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 gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

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

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

G. RS Valves in Insulated Piping: With 2-inch (50-mm) stem extensions.

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

I. <u>All valves shall be furnished with 5-foot long T-handle wrench keys.</u>

2.2 BRONZE GATE VALVES

A. Class 125, NRS, Bronze Gate Valves:

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

a. American Valve, Inc.
b. Crane; Crane Energy Flow Solutions.

c. Jenkins Valves; Crane Energy Flow Solutions.
d. KITZ Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: Bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS, Bronze Gate Valves:

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

a. American Valve, Inc.
b. Crane; Crane Energy Flow Solutions.
c. KITZ Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: Bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

C. Class 150, NRS, Bronze Gate Valves:

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

a. KITZ Corporation.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Material: 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, bronze, or aluminum.

D. Class 150, RS, Bronze Gate Valves:

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

a. Crane; Crane Energy Flow Solutions.
b. KITZ Corporation.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Material: 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, bronze, or aluminum.

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 gate valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Use gate valves for shutoff service only.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG (1035 kPa) OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller: Bronze gate valves, Class 125, with soldered ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron gate valves, Class 125, with flanged ends.

3.6 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG (1035 TO 1380 kPa))

A. Pipe NPS 2 (DN 50) and Smaller: Bronze gate valves, Class 125, with soldered ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron gate valves, Class 125, with flanged ends.

3.7 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Bronze gate valves, Class 125, with soldered ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron gate valves, Class 125, with flanged ends.

END OF SECTION 220523.15

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. 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:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

    a. Allied Tube & Conduit; a part of Atkore International.
    b. B-line, an Eaton business.
    c. Flex-Strut Inc.
    d. Thomas & Betts Corporation, A Member of the ABB Group.
    e. Unistrut; Part of Atkore International.
    f. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.
8. Paint Coating: Vinyl.
9. Plastic Coating: PVC.

B. Non-MFMA Manufacturer Metal Framing Systems:

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

    a. Anvil International.
    b. Empire Industries, Inc.
    c. ERICO International Corporation.
    d. Haydon Corporation.
    e. NIBCO INC.
    f. PHD Manufacturing, Inc.
    g. PHS Industries, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.

4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.5 PIPE STANDS

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

B. 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 base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.6 PIPE POSITIONING SYSTEMS

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

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

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

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

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

C. 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 powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

J. Install hangers and supports complete with necessary attachments, 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 (DN 65) 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 that 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 to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

Q. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting."

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

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

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), 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 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
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 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) 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 (DN 25 to DN 750), from two 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 24 (DN 65 to DN 600), 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 (DN 50 to DN 1050) 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 (DN 50 to DN 600) 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 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. 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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

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.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, 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 (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

END OF SECTION 220529

SECTION 220548 - 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. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraint channel bracings.
14. Restraint cables.
15. Seismic-restraint accessories.
16. Mechanical anchor bolts.
17. Adhesive anchor bolts.

B. Related Requirements:

1. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 vibration isolation device and seismic-restraint component required.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
3. 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 was examined for excessive stress and that none exists.
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. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency engaged by the Contractor, with the experience and capability to conduct the testing indicated, that is an NRTL and that is acceptable to authorities having jurisdiction.

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

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

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval 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 unavailable, 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 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III

a. Component Importance Factor: 1.25

b. Component Response Modification Factor: 8.0
c. Component Amplification Factor: 5.0

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 1.116g.
4. Design Spectral Response Acceleration at 1.0-Second Period: 1.674g.
5. Rated strengths, features, and applications shall be as defined in reports by [an evaluation service member of ICC-ES.

a. Structural Safety Factor: Refer to structural calculations.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

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

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Isolation.
d. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.

a. Surface Pattern: Smooth pattern.
b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: .

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

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Isolation.
d. Vibration Mountings & Controls, Inc.

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .

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

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Isolation.
d. Vibration Mountings & Controls, Inc.

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

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

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Isolation.
d. Vibration Mountings & Controls, Inc.

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. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).

7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: .

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

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. Vibration Isolation.
    d. Vibration Mountings & Controls, Inc.
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. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    b. Top housing with attachment and leveling bolt.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

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

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. Vibration Isolation.
    d. Vibration Mountings & Controls, Inc.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    b. Top plate with threaded mounting holes.
    c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: .

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

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. Vibration Isolation.
    d. Vibration Mountings & Controls, Inc.
2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- (13-mm-) thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig (3.45 MPa)on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- (13-mm-) thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .

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

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.12 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

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

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Isolation.
d. Vibration Mountings & Controls, Inc.

2. 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.
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.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.13 SNUBBERS

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

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Mountings & Controls, Inc.

B. Description: 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 (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

2.14 RESTRAINT CHANNEL BRACINGS

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

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Part of Atkore International.

B. Description: MFMA-4, shop- or field-fabricated bracing 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; rated in tension, compression, and torsion forces.

2.15 RESTRAINT CABLES

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

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Mason Industries, Inc.
4. Vibration Mountings & Controls, Inc.

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

2.16 SEISMIC-RESTRAINT ACCESSORIES

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

1. B-line, an Eaton business.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. 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.

E. 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.

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

2.17 MECHANICAL ANCHOR BOLTS

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

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. 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.

2.18 ADHESIVE ANCHOR BOLTS

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

1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC 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.

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 of the Work.

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

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.

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 is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

D. 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 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

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

G. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.

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

I. 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.

J. 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.

K. 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 Section 221116 "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Contractor, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.

7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 220548

SECTION 220553 - 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.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

a. Brimar Industries, Inc.
b. Craftmark Pipe Markers.
c. Marking Services, Inc.
d. Seton Identification Products.

2. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Black.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

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

a. Brimar Industries, Inc.
b. Craftmark Pipe Markers.
c. Marking Services, Inc.
d. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Black.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
7. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

1. Brimar Industries, Inc.
2. Craftmark Pipe Markers.
3. National Marker Company.
4. Seton Identification Products.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Red.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

G. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

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

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

2.3 PIPE LABELS

A. Retain this article if these devices will identify some or all piping. Identification of piping by color-coded painting is covered in "Pipe Label Installation" Article.

B. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.

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

1. Brimar Industries, Inc.
2. Craftmark Pipe Markers.
3. Marking Sevices Inc.
4. Seton Identification Products.

D. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

E. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

F. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

G. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

A. Stencils for Piping:

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

a. Brimar Industries, Inc.
b. Craftmark Pipe Markers.
c. Marking Sevices Inc.

2. Lettering Size: Size letters according to ASME A13.1 for piping.
3. Stencil Material: Aluminum.
4. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Retain requirement in "Action Submittals" Article to submit numbering scheme for approval.

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

1. Brimar Industries, Inc.
2. Craftmark Pipe Markers.
3. Marking Sevices Inc.
4. Seton Identification Products.

C. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brimar Industries, Inc.
2. Craftmark Pipe Markers.
3. Marking Sevices Inc.
4. Seton Identification Products.

B. Description: 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 (75 by 133 mm) minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

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 GENERAL INSTALLATION REQUIREMENTS

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.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings."

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, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations 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 (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Low-Pressure Compressed Air Piping:

   a. Background: Safety blue.
   b. Letter Colors: White.

2. High-Pressure Compressed Air Piping:

   a. Background: Safety blue.
   b. Letter Colors: White.

3. Domestic Water Piping

   a. Background: Safety green.
   b. Letter Colors: White.

4. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Safety black.
   b. Letter Color: White.

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 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 (38 mm), round.
   b. Hot Water: 1-1/2 inches (38 mm), round.
   c. Low-Pressure Compressed Air: 1-1/2 inches (38 mm), round.
   d. High-Pressure Compressed Air: 1-1/2 inches (38 mm), round.

2. Valve-Tag Colors:

   a. Cold Water: Natural.

b. Hot Water: Natural.
c. Low-Pressure Compressed Air: Natural.
d. High-Pressure Compressed Air: Natural.

3. Letter Colors:

a. Cold Water: White.
b. Hot Water: White.
c. Low-Pressure Compressed Air: White.
d. High-Pressure Compressed Air: White.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 221116 - 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. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD 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 Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

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

   a. Elkhart Products Corporation.
   b. NIBCO INC.
   c. Viega LLC.
2. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:

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

   a. Victaulic Company.
2. Description:

   a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
   b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

I. Copper-Tube, Extruded-Tee Connections:

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

   a. T-DRILL Industries Inc.
2. Description: Tee formed in copper tube according to ASTM F 2014.

J. Appurtenances for Grooved-End Copper Tubing:

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

   a. Anvil International.
   b. Shurjoint Piping Products.
   c. Victaulic Company.
2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:

   a. Copper-tube dimensions and design similar to AWWA C606.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating: 300 psig (2070 kPa).

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

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

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.

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

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51.
2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

F. Compact-Pattern, Push-on-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

H. Appurtenances for Grooved-End, Ductile-Iron Pipe:

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

   a. Shurjoint Piping Products.
   b. Smith-Cooper International.
   c. Star Pipe Products.
   d. Victaulic Company.
2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:

   a. AWWA C606 for ductile-iron-pipe dimensions.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating:

      1) NPS 14 to NPS 18 (DN 350 to DN 450): 250 psig (1725 kPa).
      2) NPS 20 to NPS 46 (DN 500 to DN 900): 150 psig (1035 kPa).

2.4 STAINLESS-STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61 Annex G.

B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10 and Schedule 40.

C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.

D. Appurtenances for Grooved-End, Stainless-Steel Pipe:

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

a. Anvil International.
b. Grinnell Mechanical Products.
c. Victaulic Company.

2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

a. AWWA C606 for stainless-steel-pipe dimensions.
b. Stainless-steel housing sections.
c. Stainless-steel bolts and nuts.
d. EPDM-rubber gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:

1) NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa).
2) NPS 10 and NPS 12 (DN 250 to DN 300): 400 psig (2758 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig (1725 kPa).

2.5 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.6 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.7 PEX-AL-PEX TUBE AND FITTINGS

A. PEX-AL-PEX Distribution System: ASTM F 1281 tubing.

B. Fittings for PEX-AL-PEX Tube: ASTM F 1281, metal-insert type with copper or stainless-steel crimp rings and matching PEX-AL-PEX tube dimensions.

2.8 PEX-AL-HDPE TUBE AND FITTINGS

A. PEX-AL-HPDE Distribution System: ASTM F 1986 tubing.

B. Fittings for PEX-AL-HDPE Tube: ASTM F 1986, metal-insert type with copper or stainless-steel crimp ring and matching PEX-AL-HDPE tube dimensions

2.9 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.

B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.

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

2.10 PP PIPE AND FITTINGS

A. PP Pipe: ASTM F 2389, SDR 7.4 and SDR 11.

B. PVC Socket Fittings: ASTM F 2389.

2.11 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

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

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

D. Flux: ASTM B 813, water flushable.

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

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

1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

2.12 ENCASEMENT FOR PIPING

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

B. Form: Sheet or tube.

C. Color: Black or natural.

2.13 TRANSITION FITTINGS

A. General Requirements:

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

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

C. Sleeve-Type Transition Coupling: AWWA C219.

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

   a. Cascade Waterworks Mfg. Co.
   b. Ford Meter Box Company, Inc. (The).
   c. Smith, Jay R. Mfg. Co.
   d. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:

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

   a. Charlotte Pipe and Foundry Company.
   b. Harvel Plastics, Inc.
   c. Spears Manufacturing Company.

2. Description:

   a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
   b. One end with threaded brass insert and one solvent-cement-socket end.

E. Plastic-to-Metal Transition Unions:

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

   a. Colonial Engineering, Inc.
   b. NIBCO INC.
   c. Spears Manufacturing Company.

2. Description:

   a. CPVC or PVC four-part union.
   b. Brass threaded end.
   c. Solvent-cement-joint plastic end.
   d. Rubber O-ring.
   e. Union nut.

2.14 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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

    a. Central Plastics Company.
    b. Watts; a Watts Water Technologies company.
    c. Wilkins.
    d. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Watts; a Watts Water Technologies company.
    d. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig (1035 kPa).
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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

    a. Grinnell Mechanical Products.
    b. Precision Plumbing Products.
    c. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

H. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. 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.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

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

R. Install PEX piping with loop at each change of direction of more than 90 degrees.

S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

U. Install thermostats in hot-water circulation piping.

V. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

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

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

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

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

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

N. Joints for PEX Piping: Join according to ASTM F 1807.

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

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) 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 (DN 50) and Smaller: Use dielectric couplings.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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 (10 mm).

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

F. Install supports for vertical copper tubing every 10 feet (3 m).

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).

I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

J. Install supports for vertical stainless-steel piping every 15 feet (4.5 m).

K. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
5. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
6. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

L. Install supports for vertical CPVC piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.

M. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.

N. Install hangers for vertical PEX piping every 48 inches (1200 mm).

O. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

P. Install supports for vertical PVC piping every 48 inches (1200 mm).

Q. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
5. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
6. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

R. Install supports for vertical PP piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.

S. 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. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

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

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

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

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

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

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) 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 (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean 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. Include copies of water-sample approvals from authorities having jurisdiction.

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

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
2. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
3. PP, SDR 11 socket fittings; and fusion-welded joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
3. Push-on-joint, ductile-iron pipe; standard- or compact-pattern, push-on-joint fittings; and gasketed joints.
4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
5. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
6. PP, SDR 11 socket fittings; and fusion-welded joints.

F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:

1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
2. Push-on-joint, ductile-iron pipe; standard- or compact-pattern, push-on-joint fittings; and gasketed joints.
3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

G. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Hard or soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and brazed joints.
2. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
3. PP, SDR 11 socket fittings; and fusion-welded joints.

H. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper, solder-joint fittings; and brazed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
4. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper push-on-joint fittings; and push-on joints.
5. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) CPVC pipe with CPVC socket fittings may be used instead of tubing.
8. PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX tube; and crimped joints.
9. PE-AL-PE tube, NPS 1 (DN 25) and smaller; fittings for PE-AL-PE tube; and crimped joints
10. PEX-AL-PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX-AL-PEX tube; and crimped joints.
11. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
12. PP, SDR 11 socket fittings; and fusion-welded joints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper, solder-joint fittings; and brazed joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
5. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
6. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
7. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
8. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
9. PP, SDR 11 socket fittings; and fusion-welded joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper, solder-joint fittings; and brazed joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
5. Stainless-steel Schedule 40 pipe, grooved-joint fittings, and grooved joints.
6. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
7. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
8. PVC, Schedule 40; socket fittings; and solvent-cemented joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated 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 221116

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

1.3 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 (30 kPa).
2. Waste, Force-Main Piping: 50 psig (345 kPa).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

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

2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

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

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. 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 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

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

2.3 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. CISPI, Hubless-Piping Couplings:

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

   a. ANACO-Husky.
   b. MIFAB, Inc.
   c. Tyler Pipe; a subsidiary of McWane Inc.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

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

   a. ANACO-Husky.
   b. MIFAB, Inc.
   c. Tyler Pipe; a subsidiary of McWane Inc.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:

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

   a. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
2. Ductile-Iron-Pipe Appurtenances:

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

1) Anvil International.
2) Smith-Cooper International.
3) Victaulic Company.

b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.5 ABS PIPE AND FITTINGS

A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

D. Solvent Cement: ASTM D 2235.

1. ABS solvent cement shall have a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

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

1) Dallas Specialty & Mfg. Co.
2) Fernco Inc.
3) Froet Industries LLC.
4) Mission Rubber Company, LLC; a division of MCP Industries.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company, LLC; a division of MCP Industries.
b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.
2) Ford Meter Box Company, Inc. (The).
3) JCM Industries, Inc.
4) Smith, Jay R. Mfg. Co.
5) Viking Johnson.
b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) or high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm) minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, 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. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. 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 two 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.

L. 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.

M. 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 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) 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.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install steel piping according to applicable plumbing code.

P. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping according to ASTM D 2661.

S. Install aboveground PVC piping according to ASTM D 2665.

T. Install underground ABS and PVC piping according to ASTM D 2321.

U. 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.

V. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

AA. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. 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. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

    a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
    b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) 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 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.

6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

I. Install supports for vertical steel piping every 15 feet (4.5 m).

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 96 inches (2400 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 (DN 100): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
4. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.

K. Install supports for vertical stainless-steel piping every 10 feet (3 m).

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

M. Install supports for vertical copper tubing every 10 feet (3 m).

N. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.

3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

O. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).

P. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 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. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

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 (30 kPa). 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 (250 Pa). 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.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) 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.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

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.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and sovent stack fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper DWV tube, copper drainage fittings, and soldered joints.
6. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) 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 sovent stack fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) 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; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-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 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.

6. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of] the following:

1. Extra Heavy Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty cast-iron hubless-piping couplings; and coupled joints.
3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
4. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Underground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:

1. Extra Heavy Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty cast-iron hubless-piping couplings; coupled joints.
3. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

G. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) shall be any of the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

H. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger shall be any of the following:

1. Hard copper tube, Type L (Type B); wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 221316

SECTION 221319 - 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. Section Includes:
1. Cleanouts.
2. Floor drains.
3. Trench drains.
4. Channel drainage systems.
5. Air-admittance valves.
6. Roof flashing assemblies.
7. Through-penetration firestop assemblies.
8. Miscellaneous sanitary drainage piping specialties.
9. Flashing materials.

B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.
2. Section 334100 "Storm Utility Drainage Piping" for storm draining piping and piping specialties outside the building.

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 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that grease interceptors, accessories, and components will withstand seismic forces defined in Section 220548 "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.

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.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.7 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.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate size and location of roof penetrations.

1.9 MAINTENANCE MATERIAL SUBMITTALS

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. Cultures: Provide 1-gal. (3.8-L) bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. (3.8-L) bottles.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Josam Company.
2) Smith, Jay R. Mfg. Co.
3) Watts; a Watts Water Technologies company.
4) Zurn Industries, LLC.

2. ASME A112.3.1, Stainless-Steel Cleanouts:

a. Manufacturers: Subject to compliance with requirements, provide products by the following:

1) Josam Company.

3. Standard: ASME A112.36.2M for cast iron ASME A112.3.1 for stainless steel for cleanout test tee.

4. Size: Same as connected drainage piping
5. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch Hubless, cast-iron soil pipe test tee as required to match connected piping.
6. Closure: Countersunk Countersunk or raised-head Raised-head, brass cast-iron plug.
7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

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

      1) Josam Company.
      2) Smith, Jay R. Mfg. Co.
      3) Watts; a Watts Water Technologies company.
      4) Zurn Industries, LLC.

2. ASME A112.36.2M, Stainless-Steel Cleanouts:

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

      1) Josam Company.
      2) Smith, Jay R. Mfg. Co.
      3) Zurn Industries, LLC.

3. ASME A112.3.1, Stainless-Steel Cleanouts:

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

      1) Josam Company.
      2) Zurn Industries, LLC.

4. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule heavy-duty, adjustable housing threaded, adjustable housing cleanout.
5. Size: Same as connected branch.
6. Type: Adjustable housing Cast-iron soil pipe with cast-iron ferrule Heavy-duty, adjustable housing Threaded, adjustable housing.
7. Body or Ferrule: Cast iron Stainless steel.
8. Clamping Device: Required.
9. Outlet Connection: Inside calk Spigot Threaded.

10. Closure: Brass plug with straight threads and gasket Brass plug with tapered threads Cast-iron plug.
11. Adjustable Housing Material: Cast iron with threads set-screws or other device.
12. Frame and Cover Material and Finish: Nickel-bronze, copper alloy Painted cast iron Polished bronze Stainless steel.
13. Frame and Cover Shape: Round.
14. Top Loading Classification: Heavy Medium Duty.
15. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
16. Standard: ASME A112.3.1.
17. Size: Same as connected branch.
18. Housing: Stainless steel.
19. Closure: Stainless steel with seal.
20. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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

    a. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Watts; a Watts Water Technologies company.
    d. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M. Include wall access.

3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk Countersunk or raised-head Raised-head, drilled-and-threaded brass cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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

    a. Smith, Jay R. Mfg. Co.
    b. Watts; a Watts Water Technologies company.
    c. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.

3. Pattern: Floor Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Drain-outlet type Integral, ASME A112.14.1, swing-check type.
10. Coating on Interior and Exposed Exterior Surfaces: Not required.
11. Top or Strainer Material: Bronze.
12. Top of Body and Strainer Finish: Polished bronze.
13. Top Shape: Round Square.
14. Dimensions of Top or Strainer: See floor plans.
15. Top Loading Classification: Medium Duty.
16. Funnel: Not required.
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
18. Trap Material: Cast iron.
19. Trap Pattern: Standard P-trap.
20. Trap Features: Not required.

2.3 TRENCH DRAINS

A. Trench Drains:

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

   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. Zurn Industries, LLC.

2. Standard: ASME A112.6.3 for trench drains.

3. Material: Ductile or gray iron.
4. Flange: Anchor.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Grate Material: Ductile iron or gray iron.
8. Grate Finish: Not required.
9. Dimensions of Frame and Grate: See floor plans.
10. Top Loading Classification: Medium Duty.
11. Trap Material: Cast iron.
12. Trap Pattern: Standard P-trap.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

   a. Acorn Engineering Company.
   b. Zurn Industries, LLC.

2. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-) thick, lead flashing collar and skirt extending at least 6 inches (150 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

   a. Open-Top Vent Cap: Without cap.
   b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
   c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.

3. Size: Same as connected soil, waste, or vent stack.
4. 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.
5. 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.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. 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 (DN 15) side inlet.

B. 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.

C. 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 1 inch (25 mm) 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.

D. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

F. 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 soil, waste, or vent piping.

2.7 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. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) 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. (3.7 kg/sq. m or 0.41-mm thickness).
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm thickness).

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) 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.

2.8 MOTORS

A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
2. Comply with requirements for vibration isolation devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
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 (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) 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 trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

H. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

I. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

J. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

K. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

L. Install fixture air-admittance valves on fixture drain piping.

M. Install stack air-admittance valves at top of stack vent and vent stack piping.

N. Install air-admittance-valve wall boxes recessed in wall.

O. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

P. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

Q. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

R. Assemble open drain fittings and install with top of hub 1 inch (25 mm) above floor.

S. Install deep-seal traps on floor drains and other waste outlets, if indicated.

T. 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.

U. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

V. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

W. Install vent caps on each vent pipe passing through roof.

X. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

Y. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

Z. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

AA. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

BB. Install wood-blocking reinforcement for wall-mounting-type specialties.

CC. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) 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 (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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 Section 076200 "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 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each equipment

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 Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Contractor to engage a factory-authorized service representative to inspect field-assembled and 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.

3.6 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 221319

SECTION 221423 - 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. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Channel drainage systems.
7. Through-penetration firestop assemblies.
8. Flashing materials.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:

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

a. MIFAB, Inc.
b. Smith, Jay R. Mfg. Co.

c. Tyler Pipe; a subsidiary of McWane Inc.
d. Watts; a Watts Water Technologies company.
e. Zurn Industries, LLC.

2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: 8- to 12-inch (203- to 305-mm) diameter.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Flow-Control Weirs: Not required.
7. Outlet: Bottom.
8. Extension Collars: Not required.
9. Underdeck Clamp: Required.
10. Expansion Joint: Required.
11. Sump Receiver Plate: Not required.
12. Dome Material: Aluminum.
13. Wire Mesh: Stainless steel or brass over dome.
14. Perforated Gravel Guard: Stainless steel.
15. Vandal-Proof Dome: Required.
16. Water Dam: 2 inches (51 mm) high.

B. Metal, MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

C. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.
3. Downspout shall be fitted with bird screen mesh.

D. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 (DN 100) outlet.

E. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes; and bird screen.
2. Size: Same as connected conductor.

2.2 CLEANOUTS

A. Floor Cleanouts:

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

a. Smith, Jay R. Mfg. Co.
b. Tyler Pipe; a subsidiary of McWane Inc.
c. Watts; a Watts Water Technologies company.
d. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule Material: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Extra-Heavy Duty.
13. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees:

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

a. MIFAB, Inc.
b. Smith, Jay R. Mfg. Co.
c. Tyler Pipe; a subsidiary of McWane Inc.
d. Watts; a Watts Water Technologies company.
e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk, brass.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:

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

a. MIFAB, Inc.
b. Smith, Jay R. Mfg. Co.
c. Tyler Pipe; a subsidiary of McWane Inc.
d. Watts; a Watts Water Technologies company.
e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.

4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Plastic Floor Cleanouts:

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

   a. IPS Corporation.
   b. Zurn Industries, LLC.
2. Size: Same as connected branch.
3. Body Material: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

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

   a. MIFAB, Inc.
   b. Smith, Jay R. Mfg. Co.
   c. Tyler Pipe; a subsidiary of McWane Inc.
   d. Watts; a Watts Water Technologies company.
   e. Zurn Industries, LLC.
2. Standard: ASME A112.14.1, for backwater valves.
3. Size: Same as connected piping.
4. Body Material: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: hubless.
7. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
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. Cast-Iron, Drain-Outlet Backwater Valves:

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

a. Smith, Jay R. Mfg. Co.
b. Watts; a Watts Water Technologies company.
c. Zurn Industries, LLC.

2. Size: Same as floor drain outlet.
3. Body Material: 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.

C. Plastic, Horizontal Backwater Valves:

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

a. IPS Corporation.
b. Oatey.
c. Zurn Industries, LLC.

2. Standard: ASME A112.14.1, for backwater valves.
3. Size: Same as connected piping.
4. Body Material: ABS.
5. Cover: Same material as body with threaded access to check valve.
6. Check Valve: Removable swing check.
7. End Connections: Socket type.

2.4 TRENCH DRAINS

A. Trench Drains:

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

a. MIFAB, Inc.
b. Smith, Jay R. Mfg. Co.
c. Tyler Pipe; a subsidiary of McWane Inc.
d. Watts; a Watts Water Technologies company.
e. Zurn Industries, LLC.

2. Standard: ASME A112.6.3, for trench drains.
3. Body Material: Cast iron.
4. Flange: Anchor.
5. Clamping Device: Not required.
6. Outlet: Bottom.
7. Grate Material: Ductile iron.
8. Grate Finish: Painted.
9. Dimensions of Frame and Grate: .
10. Top-Loading Classification: Extra-Heavy Duty.

2.5 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M,12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 6 inches (152 mm) above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate cleanouts at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains.

J. Install test tees in vertical conductors and near floor.

K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

N. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

O. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. (30-kg/sq. m) lead sheets, 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of 4.0-lb/sq. ft. (20-kg/sq. m) lead sheets, 0.0625-inch (1.6-mm) 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 the pipe size, with a minimum length of 10 inches (250 mm) and with skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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.

3.3 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.

END OF SECTION 221423

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.
4. Supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Flushometer-Valve Repair Kits: No fewer than one of each type.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

A. Water Closets: Wall mounted, top spud.

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

   a. American Standard America.
   b. Kohler Co.

2. Bowl:

   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.
   e. Height: Standard Handicapped/elderly, complying with ICC/ANSI A117.1.
   f. Rim Contour: Elongated.
   g. Water Consumption: 1.28 gal per flush.
   h. Spud Size and Location: NPS 1-1/2; top.
   i. Color: White.

3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
4. Support:

   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
   c. Water-Closet Mounting Height: ADA Compliant.

2.2 FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves, dual flush:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Sloan Valve Company.
   b. Zurn Industries, LLC.

2. Standard: ASSE 1037.

3. Minimum Pressure Rating: 125 psig .
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: 1.6 gal. per flush (full flush), 1.1 gal. per flush (reduced flush).
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats :

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

   a. American Standard America.
   b. Bemis Manufacturing Company.
   c. Kohler Co.
   d. Olsonite Seat Co.

2. Standard: IAPMO/ANSI Z124.5.

3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Required.
9. Color: White.

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 water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

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

3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224213.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Urinals.
2. Flushometer valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Flushometer-Valve Repair Kits: No fewer than one of each type.
2. Waterless Urinal Trap-Seal Cartridges: No fewer than 12 of each type.
3. Waterless Urinal Trap-Seal Liquid: Equal to 1 gal. for each urinal installed.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals: Wall hung, back outlet, washout, accessible.

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

a. American Standard America.
b. Kohler Co.

2. Fixture:

a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Washout with extended shields.
d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
e. Water Consumption: Low.
f. Spud Size and Location: NPS 3/4, top.
g. Outlet Size and Location: NPS 2, back.
h. Color: White.

3. Flushometer Valve: Sloan 186-0.125 DBP SMO, 0.125 gpf., battery operated.

4. Waste Fitting:

a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 2.

5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

2.2 URINAL FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves:

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

a. Sloan Valve Company.
b. Zurn Industries, LLC.

2. Standard: ASSE 1037.

3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.

5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
11. Consumption: 0.125 gal. per flush.
12. Minimum Inlet: NPS 3/4.
13. Minimum Outlet: NPS 3/4.

B. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

2.3 CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to urinals, allow space for service and maintenance.

2.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

2.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.16

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Lavatories.
2. Shampoo bowls.
3. Faucets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. Servicing and adjustments of automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 LAVATORIES

A. Lavatory: Oval, vitreous china, undercounter mounted.

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

a. American Standard America.
b. Kohler Co.

2. Fixture:

a. Standard: ASME A112.19.2/CSA B45.1.
b. Type: For undercounter mounting.
c. Nominal Size: Oval, 19 by 16 inches.
d. Faucet-Hole Punching: No holes.
e. Faucet-Hole Location: On countertop.
f. Color: White.
g. Mounting Material: Sealant and undercounter mounting kit.

3. Faucet: Solid-Brass, Automatically Operated Lavatory Faucets.

2.2 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets: Automatic-type, hard-wired, electronic-sensor-operated, mixing, solid-brass valve.

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

a. American Standard America.
b. Chicago Faucets; Geberit Company.

c. Sloan Valve Company.

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid brass.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm .
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Aerator.
12. Drain: Not part of faucet.

2.3 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

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

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine counters and walls for suitable conditions where lavatories will be installed.

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

3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

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

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sinks to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

A. Service Basins: Terrazzo, floor mounted.

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

a. Fiat Products.
b. Florestone Products Co., Inc.

2. Fixture:

a. Standard: IAPMO PS 99.
b. Shape: Square Five sided.
c. Nominal Size: 32 by 32 inches.
d. Height: 12 inches with dropped front.
e. Tiling Flange: Not required.
f. Rim Guard: On front top surfaces.
g. Color: Not applicable.
h. Drain: Grid with NPS 2 outlet.

3. Mounting: On floor and flush to wall.
4. Faucet: Wall mounted with Vacuum breaker Spout with Pail Hook and wall Brace by Chicago or equal.

2.2 SINKS

A. Countertop Sinks: Stainless steel, Drop-in.

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

a. Advance Tabco.
b. Elkay Manufacturing Co.
c. Just Manufacturing.

2. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.
b. Type: Ledge back.
c. Number of Compartments: One.
d. Overall Dimensions: See schedule.
e. Metal Thickness: 18 Gauge.

2.3 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets: Manual type, single-control mixing valve.

1. Commercial, Solid-Brass Faucets.

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

1) Chicago Faucets; Geberit Company.
2) Delta Faucet Company.
3) Moen Incorporated.

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Single hole.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 1.5 gpm .
8. Handle(s): Lever.
9. Mounting Type: Deck, exposed.
10. Spout Type: Swing, solid brass.
11. Vacuum Breaker: Not required for hose outlet.
12. Spout Outlet: Aerator.

2.4 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 3/8
2. Chrome-plated, rigid-copper pipe.

2.5 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

2.6 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

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

D. Packaging: Premixed and factory packaged.

PART 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 sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

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

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224713 - DRINKING FOUNTAINS

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 drinking fountains and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

A. Drinking Fountains: Stainless steel, wall mounted, Hi-Lo.

1. Stainless-Steel Drinking Fountains:

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

1) Elkay Manufacturing Co.
2) Haws Corporation.

2. Standards:

   a. Comply with ASME A112.19.3/CSA B45.4.
   b. Comply with NSF 61 Annex G.

3. Type Receptor: With back On horizontal support.
4. Receptor Shape: Round.
5. Back Panel: Stainless-steel wall plate behind drinking fountain.
6. Bubblers: Two, with adjustable stream regulator, located on deck.
7. Control: Push button.
8. Drain: Grid type with NPS 1-1/4 (DN 32) tailpiece.
9. Supply: NPS 3/8 (DN 10) with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) chrome-plated brass P-trap and waste.
11. Support: ASME A112.6.1M, Type III lavatory carrier.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set pedestal drinking fountains on floor.

C. Install recessed drinking fountains secured to wood blocking in wall construction.

D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224713

SECTION 230010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions and Division 01 Specification Sections, apply to this and the other Sections of Division 23.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
   1. Products and shop drawings submittals.
   2. Coordinated with other trades drawings.
   3. Record documents.
   4. Operating and Maintenance Manuals and equipment warranties.
   5. Rough-ins.
   6. Mechanical as-built drawings.
   7. Cutting and patching.

1.3 DRAWINGS AND MEASUREMENTS

A. Mechanical drawings are diagrammatic and indicate the general arrangement of systems and equipment, except when specifically dimensioned or detailed. Plumbing, piping, and ductwork plans are intended to show size, capacity, approximate location, direction, and general relationship of one work phase to another, but not the exact detail or arrangement.

B. As the Mechanical drawings are of small scale, it is not possible to show all necessary offsets, fittings, and accessories. Examine General Construction, Mechanical, and Electrical Drawings and Specifications; obtain exact locations, measurements, levels, etc., at the site; arrange systems accordingly; and, at no additional expense to the Owner, furnish fittings, offsets, and accessories as required.

1.4 SUBMITTALS

A. Increase, by the quantity listed below, the number of mechanical related shop drawings, product data, and samples submitted, to allow for required distribution plus two copies of each submittal required, which will be retained by the Mechanical Consulting Engineer.
   1. Shop Drawings - Initial Submittal: 1 additional blue- or black-line prints.
   2. Shop Drawings - Final Submittal: 1 additional blue- or black-line prints.
   3. Product Data: 1 additional copy of each item.
   4. Samples: 1 additional as set.

B. Additional copies may be required by individual sections of these Specifications.

1.5 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 01 Section "Submittal Procedures," to a scale of 1/4" = 1'-0" or larger; detailing elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work. Provide submittal of combined MEP drawings for the entire building.
   1. Indicate the proposed locations of piping, ductwork, equipment, and materials. Include the following:
      a. Clearances for installing and maintaining insulation.
      b. Ductwork and piping elevations.
      c. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
      d. Equipment connections and support details.
      e. Exterior wall and foundation penetrations.
      f. Fire-rated wall and floor penetrations.
      g. Sizes and location of required concrete pads and bases.
      h. Ductwork and piping support details.
      i. Valve stem movement.
   2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
   3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
   4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

1.6 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01, indicate the following installed conditions:
   1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
   2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Identification for HVAC Piping and Equipment." Indicate actual inverts and horizontal locations of underground piping.
   3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
   5. Contract Modifications, actual equipment and materials installed.

1.7 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01, include the following information for equipment items:
   1. Instructions:
      a. Provide qualified, factory-trained manufacturers' representatives to give detailed instructions to the Owner's personnel in the operation and maintenance for each piece of equipment. This training shall be done at the job site.
      b. Instructions for different items of equipment, that are component parts of a complete system, shall be given in an integrated, progressive manner. Instructors for every piece of component equipment in a system shall be available until instructions for all items included in a system are complete.
      c. Instruction periods shall be at times scheduled with the Architect-Engineer and considered concluded only when the Architect-Engineer is satisfied in regard to complete and thorough coverage. These services shall be available for a period of not less than eight hours.
   2. Data Organization:
      a. Assemble data in three-ring binders with each item clearly labeled and completely indexed by Specification Section.
      b. Identify each item in a manner consistent with names and identification numbers used in the Contract Documents and not with the manufacturer's catalog numbers. Neatly type or draft data not furnished in printed form.
   3. Data Required for Each Component and System:
      a. Equipment Description: Include item name; model number; serial number; electrical and/or mechanical characteristics' manufacturer's name, address, and phone number; order number; and other data found on equipment data/nameplates.
      b. Component and Assembly Drawings/Master Parts List: Include exploded views and/or master parts lists clearly identifying parts and subassemblies by the manufacturer's part number. Master parts list shall include source of supply.
      c. Spare Parts Data: Include a complete list of recommended replacement parts for keeping in stock supply for equipment, including sources of supply. Include belts for belt-driven equipment in the listing. Data shall include belt manufacturer, model number, size and style, and indication if it is of a multiple belt set.
      d. Control Diagrams and Sequences of Operation: Include operating instructions, control and electrical schematics, building controls architecture, interconnection with the campus controls. Include normal start-up, normal shutdown, and emergency shutdown as applicable. Include Sequences of Controls Operation for each HVAC system.
      e. Performance Characteristics: Include performance curves for full range of operation.
      f. Installation Instructions: Include adjustment/alignment procedures, checkout procedures, and test procedures.
      g. Preventative Maintenance Procedures: Include inspection, cleaning, adjustment, service, and lubrication instructions. Furnish a schedule for each

piece of equipment and list the manufacturer's recommended maintenance routine of specific tasks to be performed at specific intervals such as daily, weekly, monthly, or quarterly or based on the number of operating hours. Preventive maintenance schedules shall take operating conditions into account.

h. Corrective Maintenance Procedures: Include instructions for troubleshooting, repair, overhaul, and calibration.

i. Special Items: Include lists of special tools, special protective clothing, special test equipment, hazards, and safety precautions.

j. Valve Directory: Include valve number, location function, and/or equipment controlled.

k. Reports: Include air and water testing and balancing, equipment start-up, and equipment warranties.

l. Submit factory and the contractor warranties for all HVAC equipment and installation specific to this project and covering warranty start from the date of acceptance of systems by the commissioning agency.

m. Submit two complete sets of operation and maintenance data to the Architect-Engineer at least 60 days prior to the time that system or equipment tests are to be performed.

n. Submit remaining two data sets to the Architect-Engineer within 20 days following tests complete with any corrections.

B. Provide a complete operations and maintenance manual referenced to OEM the specifications and plans by Division, Section, and sheet numbers. Manual shall contain manufacturers printed data of operation and maintenance instruction books, parts lists, catalogs, special tools required, fan curves, pump curves, valve directories, and any other material pertinent to that system or equipment. Provide a list of local companies to service/repair equipment.

C. Complete "cold start-up" procedures for all systems and equipment shall be required along with the mode of operation for each system in a comprehensive narrative form.

1.8 DEMONSTRATION AND TRAINING

A. Require a minimum of 10 full 24-hour days of operation prior to formal test with the commissioning agency and the Owner's representatives present.

B. Require all tests to be inspected by the Owner's representative with at least 3 working days advanced notice and provide written certification of test results.

C. Provide training per Division 01 and Division Specifications.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

PART 2 - PRODUCTS - (Not Applicable)

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 02 through 33 for rough-in requirements.

3.2 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
   1. Coordinate mechanical systems, equipment, and materials installation with other building components.
   2. Verify all dimensions by field measurements.
   3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
   4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
   5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
   6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service. Contact natural gas and water utilities and provide required engineering drawings and information.
   8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
   9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
   10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
   11. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Panels" and Division 23 Section "Common Work Results."
   12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
   13. No work shall be permitted without the approved coordinated shop drawings.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Section "Cutting and Patching." In addition to the requirements specified in Division 01, the following requirements apply:
   1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   1. Uncover Work to provide for installation of ill-timed Work.
   2. Remove and replace defective Work.
   3. Remove and replace Work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed Work as specified for testing.
   5. Install equipment and materials in existing structures.
   6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
   1. Patch finished surfaces and building components using new materials matching already installed materials and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
      a. Refer to Division 01 Section "References" for definition of "experienced Installer."
   2. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
      a. Refer to Division 01 Section "References" for definition of "experienced Installer."

END OF SECTION 230010

SECTION 230130.51 - HVAC AIR-DISTRIBUTION SYSTEM CLEANING

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 cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

1.3 DEFINITIONS

A. ASCS: Air systems cleaning specialist.

B. NADCA: National Air Duct Cleaners Association.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For an ASCS.

B. Strategies and procedures plan.

C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.

1. Certification: Employ an ASCS certified by NADCA on a full-time basis.

B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

C. Cleaning Conference: Conduct conference at the project site.

1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.

C. Prepare written report listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:

1. Supervisor contact information.
2. Work schedule including location, times, and impact on occupied areas.
3. Methods and materials planned for each HVAC component type.
4. Required support from other trades.
5. Equipment and material storage requirements.
6. Exhaust equipment setup locations.

B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

A. Comply with NADCA ACR 2006.

B. Remove visible surface contaminants and deposits from within the HVAC system.

C. Systems and Components to Be Cleaned:

1. Air devices for supply and return air.
2. Air-terminal units.
3. Ductwork:

a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
b. Return-air ducts to the air-handling unit.
c. Exhaust-air ducts.

4. Air-Handling Units:

a. Interior surfaces of the unit casing.
b. Coil surfaces compartment.
c. Condensate drain pans.
d. Fans, fan blades, and fan housings.

5. Filters and filter housings.

D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

E. Particulate Collection:

1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

F. Control odors and mist vapors during the cleaning and restoration process.

G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

I. Clean all air-distribution devices, registers, grilles, and diffusers.

J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:

1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
3. Clean evaporator coils, reheat coils, and other airstream components.

K. Duct Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).

L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

M. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

    a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
    b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.

2. Cleaning Mineral-Fiber Insulation Components:

    a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
    b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
    c. Fibrous materials that become wet shall be discarded and replaced.

N. Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.

6. Rinse thoroughly with clean water to remove any latent residues.

O. Antimicrobial Agents and Coatings:

1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

3.4 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

E. Verification of Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of manufacturers pressure drop data for the coil for the design airflow, the differential measured when the coil was first installed.
3. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

F. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.

3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.
6. Photographic documentation demonstrating clean ductwork, accessories and equipment,

3.5 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Section 233113 "Metal Ducts." Include location of service openings in Project closeout report.

C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

D. Replace damaged insulation according to Section 230713 "Duct Insulation."

E. Ensure that closures do not hinder or alter airflow.

F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

G. Reseal fibrous-glass ducts. Comply with requirements in Section 233116 "Nonmetal Ducts."

END OF SECTION 230130.51

SECTION 23 0513 - 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 NEMA MG 1 unless otherwise indicated.

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

2.2 MOTOR CHARACTERISTICS

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

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

2.3 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

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

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

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

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

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

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

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

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. 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.

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 230513

SECTION 23 0514 - VARIABLE FREQUENCY / SPEED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, test and install variable (speed) controllers (VFDs) where shown and scheduled on the Drawings and as specified in this Section.

B. The Electrical Contractor shall be responsible for power connections to the VFD and the controller motor.

C. The Control Subcontractor shall provide all control wiring and interlocks to the invertor.

D. NEMA 3R enclosure.

E. 3-year warranty.

1.2 QUALITY ASSURANCE

A. Comply with NFPA 70, "National Electrical Code."

B. NRTL Listing: Provide NRTL listed motors.

1. Term "Listed": As defined in "National Electrical Code," Article 100.
2. Listing Agency Qualifications: "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Comply with NEMA MG 1, "Motors and Generators."

D. Comply with UL 1004, "Motors, Electric."

1.3 COMPATIBILITY

A. The drive shall be totally compatible with the type of motor and load it shall power and control. The supplier of the drive equipment shall coordinate and insure this compatibility. Refer to NEC Table 430-150 for minimum drive amp requirements for various motor HP ratings.

B. All VFDs furnished by the Contractor under this Section shall be of one brand (manufacturer) for both fan and pump applications. Mixing of brands shall not be allowed.

1.4 SUBMITTALS

A. General: Submit complete shop drawings including connection diagrams, control schematics, and operation and maintenance manual as follows:

1. Outline drawings showing dimensions, sizes, weights, component locations, etc.
2. Connection diagrams identifying line, load, and external control connection points. Terminal and conductor identification shall correspond to power and control schematics submitted under other sections.
3. Internal wiring diagrams showing internal components and associated interconnections. Drawings shall be sufficiently complete to allow the engineer to determine compliance with specifications.
4. Operation and Maintenance Manual shall include a complete technical description of operation of the unit, complete setup instructions, a troubleshooting guide, a complete parts list with number identifications, and a list of recommended spare parts.
5. Submit test as required by the start-up services section for review and approval.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Approved Manufacturers:

1. ABB
2. Danfoss, Inc.
3. Toshiba
4. Yaskawa
5. Approved equal

B. Variable frequency drive (VFD) shall be suitable for control of standard NEMA Design B 3-phase induction motor.

2.2 VARIABLE FREQUENCY MOTOR CONTROLLER

A. Shall be either 6-step or PWM type and shall produce a 3-phase output capable of providing efficient operation of standard NEMA or IEC design AC induction motors.

1. The control shall consist of a power section made up of a fixed AC to DC converter, a fused filter, storage network, and an inverter, using either bipolar transistors or IGBTs in the power switching section.
2. Drives shall have a logic control section which is microprocessor based, using a 16-bit processor and LSI for minimum part count and maximum reliability. Adjustments shall be made via digital keypad rather than potentiometers.
3. The power section shall be isolated from the control section between the driver output of the control printed circuit card and the power switching devices.

B. The VFD drive shall be operable in two modes.

1. In the "HAND" mode, the unit shall start and run at a speed as set on the manual potentiometer.
2. In the "AUTO" mode, the unit shall start in response to a contact closure and run at a speed established by an analog control signal.
3. Opening of remote safety loop shall disable operation in any mode.

C. Specifications:

1. Input power 3-phase, 60 Hz, 460 VAC.

    a. Nominal input voltage +/- 10%
    b. +/- 5% input frequency stability

2. Provide AC line (input) rectors with 3 percent impedance, mounted and wired in VFD cabinet for both 6-step and PWM drives.
3. Minimum continuous VFD amps and minimum line rector inductance shall be as follows:
4. Comply to FCC Subpart J of Part 15 for Class A computing device from 7 MHZ to 30 MHZ for conduction limit without external modification.
5. Output Power: 3-phase, 1.2 to 80 Hz with variable voltage to give proper and efficient operation of variable torque load.
6. Overload capacity of 125 percent for 1 minute.
7. Input power factor, 95 percent minimum at all speeds and loads.
8. Provide gasketed NEMA 1 enclosure of 14 gage steel (minimum) with single door, heavy continuous hinge, and padlock hasp. VFD display and keypad shall be accessible with door open or closed.

D. Minimum Requirements for Control Operation and Service:

1. Door-interlocked, fused disconnect switch, heavy duty type with provision for padlocking with up to three padlocks. Interlock handle shall be of heavy cast metal (not plastic) construction. Fuses shall be 200,000 AIC, Class R, dual element type.
2. Isolated 115 VAC control transformer with fused primary and secondary per 2005 NEC (or latest edition) and with 120V, 10-amp relay for safeties and for remote start contacts.
3. Digital annunciated fault and limit functions individually annunciated for:

    a. Thermal overload relay trip
    b. Microprocessor self-check function
    c. Output overcurrent trip
    d. DC bus overvoltage trip
    e. Inverse time overload trip
    f. Heatsink over-temperature trip
    g. DC bus fuse open
    h. DC bus overvoltage (regen. limit)

i. Output ground fault
j. Undervoltage/phase loss

Note: The VFD shall retain at least the last four faults for display, in order of occurrence.

4. Lamp annunciated functions for:

a. Inverter ready light
b. Inverter run light
c. Inverter safeties okay light (green)
d. Power line on light
e. Inverter stop light

E. Minimum Required Standard Features:

1. Door mounted components:

a. Inverter run indication
b. Remote safety indication
c. Digital speed (frequency or percent speed) and motor ammeter
d. Manual speed potentiometer
e. Hand/Off/Auto selector switch (heavy duty oil-tight type)
f. Reset push-button for fault and enable
g. Annunciation as in Paragraph D.

2. DC bus charged indicator.
3. Adjustable current limit circuit active to prevent nuisance tripping during acceleration or run conditions.
4. Regeneration limit circuit active to prevent nuisance OV tripping during deceleration.
5. Minimum and maximum speed set, separate and non-interactive. Operation higher than maximum speed setting shall not be possible, even if remote signal exceeds nominal maximum (i.e. 25 ma on a 20 ma circuit).
6. Power loss restart selectable for Auto Restart in auto mode only.
7. Critical frequency lockout for up to 3 points, available from 10 to 100 percent speed with an adjustable bandwidth.
8. Only non-filament type indicating lights may be used.
9. Control shall survive without component failure and annunciate output phase-to-phase ground faults.
10. Control shall have the following isolated instrument control signal follower: 4 to 20 madc or 0 to 10 vdc.
11. Volts per hertz ratio shall be automatic, tracking motor load requirements to achieve most efficient operation; potentiometer adjustments not allowed. Control shall have available 15 selectable volts per hertz patterns.
12. To reduce possible acoustical noise and electrical interference, PWM type drive control must have an automatically variable carrier frequency of at least 380 to 2500 hertz. Carrier frequency must be field adjustable. There shall be no sudden frequency shifts which may cause acoustical noise increases during changes in frequency output to motor.

13. Control shall be capable of starting into a spinning motor. Must also be capable of stopping a motor rotating in the reverse direction and then accelerating that motor in the proper direction.
14. A three-pole thermal motor overload relay with Class 10 heaters connected to shut down the motor on trip-out, in addition to VFD time-overcurrent motor protection. VFD electronic overload shall reduce amp level at speeds below 50 percent to compensate for reduced motor capacity at low speeds.
15. All components must be supplied in an integral enclosure with a single door; separate enclosures are not allowed.
16. Provide auxiliary contacts for VFD run and VFD fault, wired to terminals for customer use.
17. Control shall be "ride-through" momentary power losses of 2 seconds or less.
18. All controls under 150 horsepower will require ETL or U/L nationally recognized testing laboratory approval.
19. Provide manual/automatic bypass for each drive.

    a. Provide manual bypass with soft-start function on VFDs.

20. Provide line reactors, harmonic filters or any other devices necessary to maintain 5 percent or less voltage and current distortion at the VFD mounted disconnect.
21. Drive and bypass U.L. labeled.
22. Drive test capabilities during bypass operation.
23. Provide factory mounted disconnect switch with minimum 100,000-amp short circuit withstand rating.
24. VFD shall be limited to 5 percent voltage and current distortion at the VFD mounted disconnect.
25. The VFD is to be provided with transitional or other devices necessary to complete bi-directional communication with temperature control system. All data at VFD control panel shall be available at DDC-front end computer. Refer to Division 23 Section "Instrumentation and Control for HVAC."

2.3 QUALITY ASSURANCE TESTS

A. The following quality assurance factory tests and procedures shall be conducted on the drive and its components prior to shipment.

1. SCRs and diodes shall be tested to ensure correct function and highest reliability.

    a. Every controller will be functionally tested under designed motor load for eight hours to ensure that if the drive is started up according to the instruction manual provided, that unit will run properly.
    b. The VFD manufacturer shall provide certification that the tests have been completed.

2. Each VFD shall be tested for voltage and current distortion by a factory qualified or independent qualified source. The voltage and current distortion shall be 5 percent or less when tested at the VFD mounted disconnect through the operating range of the VFD.

    a. The following reading shall be included in the test reports for each VFD:

        1) input KVA
        2) total power factor
        3) 3-phase input voltage
        4) 3-phase current
        5) 3-phase input voltage total harmonic distortion (THD)
        6) 3-phase input total demand distortion (TDD)

    b. For review and approval, a report shall be submitted to the Engineer/Architect indicating the voltage and current distortion for each drive. If any VFD does not meet the 5 percent voltage and current distortion performance requirements, the Contractor is responsible for upgrading the VFD to meet specified requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: The drives shall be installed, tested, and calibrated in accordance with Division 23 Section "Basic Mechanical Requirements," and manufacturer's recommendations.

B. All outdoor mounted VFDs shall be housed in NEMA 3R enclosure.

3.2 STARTUP SERVICES

A. The Variable Frequency Drive (VFD) manufacturer shall provide, as a minimum, the following services:

1. Factory coordinated startup service for each and every drive with written deficiency reports.
2. Training of Owner's personnel in basic operation and troubleshooting. Training shall be on-site, shall be a minimum of three days' duration, and shall be performed in addition to startup of system.

3. Each VFD manufacturer shall have a local representative specifically trained in troubleshooting and service and repair of its VFD. A statement of the length and extent of experience of the local service organization shall be included with the submittals.

END OF SECTION 230514

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible, ball-joint, packed expansion joints.
2. Slip-joint packed expansion joints.
3. Expansion-compensator packless expansion joints.
4. Flexible-hose packless expansion joints.
5. Metal-bellows packless expansion joints.
6. Grooved-joint expansion joints.
7. Pipe loops and swing connections.
8. Alignment guides and anchors.

1.2 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.3 ACTION 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 swing connections based on the actual provided layout. Calculations and the design drawings shall be stamped and signed by a structural engineer licensed in the State of California.
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.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of expansion joint, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKED EXPANSION JOINTS

A. Flexible, Ball-Joint, Packed Expansion Joints:

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

a. Advanced Thermal Systems, Inc.
b. Hyspan Precision Products, Inc.
c. Mason Industries, Inc.
d. Or approved equal.

2. Standards: ASME Boiler and Pressure Vessel Code: Section II, "Materials"; and ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.
3. Material: Carbon-steel assembly with asbestos-free composition packing.
4. Design: For 360-degree rotation and angular deflection.
5. Minimum Pressure Rating: 250 psig at 400 deg F.
6. Angular Deflection for NPS 6 and Smaller: 30-degree minimum.
7. Angular Deflection for NPS 8 and Larger: 15-degree minimum.
8. End Connections for NPS 2 and Smaller: Threaded.
9. End Connections for NPS 2-1/2 and Larger: Flanged.

B. Slip-Joint Packed Expansion Joints:

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

a. Adsco Manufacturing LLC.
b. Advanced Thermal Systems, Inc.
c. Hyspan Precision Products, Inc.
d. Mason Industries, Inc.
e. Or approved equal.

2. Standard: ASTM F 1007.
3. Material: Carbon steel with asbestos-free PTFE packing.
4. Design: With internal guide and injection device for repacking under pressure. Include drip connection if used for steam piping.
5. Configuration: Single joint, single joint with base and double joint with base class(es) unless otherwise indicated.
6. End Connections: Flanged or weld ends to match piping system.

2.2 PACKLESS EXPANSION JOINTS

A. Metal, Expansion-Compensator Packless Expansion Joints:

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

a. Adsco Manufacturing LLC.
b. Flex Pression Ltd.
c. Flex-Weld, Inc.
d. Flexicraft Industries.
e. Hyspan Precision Products, Inc.
f. Mason Industries, Inc.
g. Metraflex Company
h. Senior Flexonics Pathway.
i. Unaflex.
j. Unisource Manufacturing, Inc.
k. Or approved equal.

2. Minimum Pressure Rating: 175 psig unless otherwise indicated.
3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.

a. End Connections for Copper Tubing NPS 2 and Smaller: Threaded.
b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.

4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.

a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.

B. Rubber, Expansion-Compensator Packless Expansion Joints:

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

   a. Amber/Booth Company, Inc.
   b. Flex-Hose Co., Inc.
   c. Flexicraft Industries.
   d. General Rubber Corporation.
   e. Mason Industries, Inc.
   f. Proco Products, Inc.
   g. Tozen Corporation.
   h. Unaflex.
   i. Unisource Manufacturing, Inc.
   j. Or approved equal.

2. Material: Twin reinforced-rubber spheres with external restraining cables.
3. Minimum Pressure Rating: 150 psig at 170 deg F unless otherwise indicated.
4. End Connections for NPS 2 and Smaller: Threaded.

C. Flexible-Hose Packless Expansion Joints:

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

   a. Flex Pression Ltd.
   b. Flex-Hose Co., Inc.
   c. Flexicraft Industries.
   d. Mason Industries, Inc.
   e. Metraflex Company
   f. Unisource Manufacturing, Inc.
   g. Or approved equal.

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with threaded end connections.

   a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
   b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.

    a. 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. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

D. Metal-Bellows Packless Expansion Joints:

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

    a. Adsco Manufacturing LLC.
    b. American BOA, Inc.
    c. Badger Industries, Inc.
    d. Expansion Joint Systems, Inc.
    e. Flex Pression Ltd.
    f. Flex-Hose Co., Inc.

g. Flex-Weld, Inc.
h. Flexicraft Industries.
i. Flo Fab inc.
j. Hyspan Precision Products, Inc.
k. Mason Industries, Inc.
l. Metraflex Company
m. Proco Products, Inc.
n. Senior Flexonics Pathway.
o. Tozen Corporation.
p. U.S. Bellows, Inc.
q. Unaflex.
r. Unisource Manufacturing, Inc.
s. Universal Metal Hose.
t. WahlcoMetroflex.
u. Or approved equal.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 175 psig unless otherwise indicated.
5. Configuration: Single joint, single joint with base and double joint with base class(es) unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

   a. End Connections for Copper Tubing NPS 2 and Smaller: Threaded.
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
   c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

7. Expansion Joints for Steel Piping: Single- or multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.

   a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
   b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

2.3 GROOVED-JOINT EXPANSION JOINTS

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

   1. Anvil International, Inc.
   2. Shurjoint Piping Products.
   3. Victaulic Company.
   4. Or approved equal.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water or EPDM gasket suitable for cold and hot water, and bolts and nuts.

2.4 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

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

   a. Adsco Manufacturing LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flex-Hose Co., Inc.
   d. Flex-Weld, Inc.
   e. Flexicraft Industries.
   f. Hyspan Precision Products, Inc.
   g. Mason Industries, Inc.
   h. Metraflex Company
   i. Senior Flexonics Pathway.
   j. U.S. Bellows, Inc.
   k. Unisource Manufacturing, Inc.
   l. Or approved equal.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install packed-type expansion joints with packing suitable for fluid service.

C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

D. Install rubber packless expansion joints according to FSA-NMEJ-702.

E. Install grooved-joint expansion joints to grooved-end steel piping

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. 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.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach per the manufacturer's recommendations.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS 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. Sleeves.
2. Stack-sleeve fittings.
3. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

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

2.2 STACK-SLEEVE FITTINGS

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

1. Smith, Jay R. Mfg. Co;
2. Zurn Industries, LLC;
3. Approved equal.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in floors, roof slabs, and concrete walls as slabs and walls are constructed.
1. Cut sleeves to length for mounting flush with bottom of slab surfaces.
2. Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
4. Provide fire proofing per the UL-Listed details issued by the fire proofing manufacturer.

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Using grout, seal the space around outside of stack-sleeve fittings.

3.3 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller than NPS 6: Galvanized-steel wall sleeves Galvanized-steel-pipe sleeves.

2. Concrete Slabs above Grade:

a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves Stack-sleeve fittings.

3. Interior Partitions:

a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION 230517

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.
   7. Thermal energy (BTU) flowmeters.

B. Related Sections:

   1. Section 231123 "Facility Natural-Gas Piping" for gas meters.

1.3 ACTION SUBMITTALS

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

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Trerice, H. O. Co.
   b. Weiss Instruments, Inc.
   c. Winters Instruments - U. S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   a. Trerice, H. O. Co.
   b. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   c. Weiss Instruments, Inc.
   d. WIKA Instrument Corporation - USA.
   e. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.

9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.3 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass or stainless-steel needle], with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Peterson Equipment Co., Inc.
2. Trerice, H. O. Co.
3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
4. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

2.5 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Peterson Equipment Co., Inc.
2. Trerice, H. O. Co.
3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
4. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing one thermometer, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psi.

E. Carrying Case: Metal or plastic, with formed instrument padding.

2.6 FLOWMETERS

2.7 THERMAL-ENERGY (BTU) METERS

A. Impeller-Turbine, Thermal-Energy Meters:

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

    a. Data Industrial Corp.
    b. Emerson Process Management; Rosemount.
    c. Hoffer Flow Controls, Inc.
    d. Spirax Sarco, Inc.

2. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
3. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.

    a. Design: Total thermal-energy measurement.
    b. Minimum Pressure Rating: 150 psig.
    c. Minimum Temperature Range: 40 to 250 deg F.

4. Temperature Sensors: Insertion-type transducer.
5. Indicator: Solid-state, integrating-type meter with integral battery pack; for wall mounting.

    a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
    b. Battery Pack: Five-year lithium battery.

6. Accuracy: Plus, or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
8. Strainer: Full size of main line piping.

9. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install valve and syphon fitting in piping for each pressure gage for steam.

I. Install test plugs in piping tees.

J. Install flow indicators in piping systems in accessible positions for easy viewing.

K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

L. Install flowmeter on chilled water system and heating hot water system.

M. Install flowmeter elements in accessible positions in piping systems.

N. Install flowmeter elements between pipe flanges.

O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

P. Install permanent indicators on walls or brackets in accessible and readable positions.

Q. Install connection fittings in accessible locations for attachment to portable indicators.

R. Mount thermal-energy meters on brackets to support meters.

S. Install thermometers in the following locations:
1. Inlet and outlet of each hydronic boiler.
2. At the air handling unit cooling coil inlet and outlet.

T. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic boiler shall be the following:
1. Industrial-style, liquid-in-glass type.

B. Thermometers at inlet and outlet of each hydronic coil at VAV box shall be the following:
1. Test plug with EPDM self-sealing rubber inserts.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 80 to 220 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be the following:

1. Liquid-filled Sealed, direct-mounted, metal case.

B. Pressure gages at suction and discharge of each pump shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

B. Scale Range for Steam Piping: 0 to 160 psi.

3.8 FLOWMETER SCHEDULE

3.9 THERMAL-ENERGY METER SCHEDULE

A. Thermal-Energy Meters for Heating, Hot-Water system: Impeller-turbine type.

END OF SECTION 230519

SECTION 23 0523 - 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 ball valves.
2. Iron, single-flange butterfly valves.
3. Bronze lift check valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Lubricated plug valves.
8. Eccentric plug valves.

B. Related Sections:

1. Section 230553 "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.

1.4 ACTION 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 indicated and as required for system pressures and temperatures.

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

D. Valve Actuator Types:
1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.

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

F. Valve-End Connections:

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

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

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:

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

a. Hammond Valve.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Crane Co.; Crane Valve Group; Crane Valves.

2. 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.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron.

2.3 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.

c. NIBCO INC.
d. Milwaukee Valve Company.

2. Description:

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

2.4 BRONZE BALL VALVES

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

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Lance Valves; a division of Advanced Thermal Systems, Inc.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. 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.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

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

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

    a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    b. Conbraco Industries, Inc.; Apollo Valves.
    c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
    d. Crane Co.; Crane Valve Group; Jenkins Valves.
    e. Crane Co.; Crane Valve Group; Stockham Division.
    f. DeZurik Water Controls.
    g. Milwaukee Valve Company.
    h. NIBCO INC.
    i. Spence Strainers International; a division of CIRCOR International.
    j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. 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.

2.6 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Crane Co.; Crane Valve Group; Stockham Division.
    d. Milwaukee Valve Company.
    e. NIBCO INC.
    f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 200 psig..
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: Bronze.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

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

a. NIBCO INC.
b. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 6, 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.
h. Closure Control: Factory-installed, exterior lever and spring.

2.8 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

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

a. Nordstrom Valves, Inc.
b. Equal

2. Description:

a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Pattern: Regular or short.
e. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:

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

a. Nordstrom Valves, Inc.
b. Equal.

2. Description:

a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Pattern: Regular or short.
e. Plug: Cast iron or bronze with sealant groove.

C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:

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

a. Homestead Valve; a division of Olson Technologies, Inc.
b. Milliken Valve Company.
c. R & M Energy Systems; a unit of Robbins & Myers, Inc.

2. Description:

a. Standard: MSS SP-78, Type IV.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Pattern: Regular or short.
e. Plug: Cast iron or bronze with sealant groove.

D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:

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

a. Homestead Valve; a division of Olson Technologies, Inc.
b. Milliken Valve Company.
c. R & M Energy Systems; a unit of Robbins & Myers, Inc.

2. Description:

a. Standard: MSS SP-78, Type IV.
b. NPS 2-1/2 to NPS, CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Pattern: Regular or short.
e. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

E. Install chainwheels on operators for ball, butterfly, globe and plug valves NPS 4 and larger and more than 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 and Plate-Type Check Valves: In horizontal or vertical position, between flanges.

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 valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Ball, or butterfly valves.
4. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
    b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. 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.

C. Select valves, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
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 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: Threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two-piece, full port, brass or bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis stamped and signed by a qualified professional structural engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Calculations signed and sealed by a professional structural engineer registered in the state of California. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

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

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut Corporation; Tyco International, Ltd.
    g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Paint Coating: Epoxy.

B. Non-MFMA Manufacturer Metal Framing Systems:

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

    a. Anvil International; a subsidiary of Mueller Water Products Inc.
    b. Empire Industries, Inc.
    c. ERICO International Corporation.
    d. Haydon Corporation; H-Strut Division.
    e. NIBCO INC.

f. PHD Manufacturing, Inc.
g. PHS Industries, Inc.

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

2.4 THERMAL-HANGER SHIELD INSERTS

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

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

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

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

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

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.6 PIPE STANDS

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

B. 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 base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

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

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

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

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, 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.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: 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 a minimum dry film thickness of 2.0 mils.

B. Touchup: Provide cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

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

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction 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.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

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

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

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS 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. Open-spring isolators.
2. Housed-spring isolators.
3. Housed-restrained-spring isolators.
4. Pipe-riser resilient supports.
5. Resilient pipe guides.
6. Spring hangers.
7. Snubbers.
8. Seismic-restraint accessories.
9. Mechanical anchor bolts.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 vibration isolation device and seismic-restraint component required.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators, seismic restraints, complying with performance requirements, design criteria, and analysis data signed and sealed by registered in California professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. 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 was examined for excessive stress and that none exists.
4. Seismic- and Wind-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
    d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports shall be prepared in compliance with the Par. 1.7.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: To be included in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Quality assurance inspection are part of the scope of the contractor's work. The contractor shall carefully review all quality assurance specification requirements to ensure they are relevant and not over burdening of the Owner for increases to project costs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

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

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

E. 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 unavailable, 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 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Building Risk Category: III.
2. Wind Velocity: 115 MPH
3. Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the CBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the CBC: II.

    a. Component Importance Factor: 1.0.
    b. Component Response Modification Factor: 2.5.
    c. Component Amplification Factor: 2.5.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second).
4. Design Spectral Response Acceleration at 1.0-Second Period.
5. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

    a. 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 are subjected.

2.2 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

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

    a. California Dynamics Corporation.
    b. Kinetics Noise Control, Inc.
    c. M.W. Sausse.
    d. Mason Industries, Inc.
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. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.3 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: .

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

    a. California Dynamics Corporation.
    b. Kinetics Noise Control, Inc.
    c. M.W. Sausse.
    d. Mason Industries, Inc.
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. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top housing with attachment and leveling bolt threaded mounting holes and internal leveling device elastomeric pad.

2.4 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.5 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.6 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Kinetics Noise Control, Inc.
    d. MW Sausse
2. 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.
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.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.7 SNUBBERS

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

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Mountings & Controls, Inc.
4. MW Sausse

B. Description: 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.

2.8 RESTRAINT CHANNEL BRACINGS

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

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Part of Atkore International.

B. Description: MFMA-4, shop- or field-fabricated bracing 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; rated in tension, compression, and torsion forces.

2.9 SEISMIC-RESTRAINT ACCESSORIES

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

1. B-line, an Eaton business.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. 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.

E. 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.

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

2.10 MECHANICAL ANCHOR BOLTS

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

1. B-line, an Eaton business.

2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. 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.

2.11 ADHESIVE ANCHOR BOLTS

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

1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC 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.

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 of the Work.

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

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners 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 is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete".

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports, and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. 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 60 feet o.c.
3. Brace a change of direction longer than 12 feet.

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

G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

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

I. 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.

J. 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.

K. 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. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to conduct DSA required tests and inspections. The contractor shall assist in conducting tests.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. Test and adjust restrained-air-spring isolator controls and safeties.

C. Remove and replace malfunctioning units and retest as specified above.

D. 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.

3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete"

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Obtain from the owner naming and types provided for Allied Health and Infrastructure projects.

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.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark Pipe Markers.
    f. Seton Identification Products.

2. predrilled or stamped holes for attachment hardware.
3. Letter Color: Black.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark Pipe Markers.
    f. Seton Identification Products.

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

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

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Marking Sevices Inc.
6. Stranco, Inc.

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

C. Letter Color: Red.

D. Background Color: Yellow.

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

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

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

H. Fasteners: Stainless-steel rivets or self-tapping screws.

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

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

2.3 PIPE LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Marking Sevices Inc.
6. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to indoor located pipe without fasteners or adhesive. Provide fasteners for the outdoor located piping

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters at least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Marking Services Inc.
6. Seton Identification Products.

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

C. Letter Color: Black.

D. Background Color: White.

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

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

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

H. Fasteners: Stainless-steel rivets or self-tapping screws.

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

J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 STENCILS

A. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

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

   a. Brimar Industries, Inc.
   b. Carlton Industries, LP.
   c. Champion America.
   d. Marking Sevices Inc.
2. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Fiberboard or metal.
4. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.6 VALVE TAGS

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

1. Brady Corporation.

2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Marking Services Inc.
6. Seton Identification Products.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Marking Services Inc.
5. Seton Identification Products.

B. Description: 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 minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

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 GENERAL INSTALLATION REQUIREMENTS

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.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping shall be as provided for the Allied Health and Infrastructure projects. Any additional colors shall be as specified in Section 099123 "Interior Painting."

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule shall be as provided for the Allied Health and Infrastructure projects. Any additional colors shall be as indicated below:
   1. Condenser-Water Piping: White letters on a safety-green background.
   2. Heating Water Piping: Black letters on a safety-orange background.
   3. Refrigerant Piping: White letters on a safety-gray background.

3.5 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the color code as provided for the Allied Health and Infrastructure projects. Any additional colors shall be as indicated below:

   1. Blue: For cold-air supply ducts.
   2. Yellow: For toilet exhaust ducts.
   3. Green: For return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 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. Refrigerant: 1-1/2 inches, round.
      b. Chilled and Hot Water: 1-1/2 inches, round.
      c. Gas: 1-1/2 inches, round.

C. Valve-Tag Colors shall be as provided for the Allied Health and Infrastructure projects. Any additional colors shall be as indicated below:
      a. Potable and Other Water: White letters on a safety-green background.
      b. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - 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. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.
   c. Primary-secondary hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. TAB: Testing, adjusting, and balancing.

C. TAB Specialist: An entity engaged to perform TAB Work.

D. EOR: Engineer Of Record

1.4 INFORMATIONAL 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 45 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.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.

B. TAB Conference: Meet with Architect, Owner, Construction Manager and 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 EOR and Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

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 air plenums used for supply and return air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. 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. Verify fire/smoke 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" and in this Section.

1. Comply with requirements in ASHRAE 62.1, 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 Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping 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 Section 233113 "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.
e. Measure inlet static pressure across bag-in-bag-out filter bank.

3. Measure static pressure across each component that makes up an air-handling unit, evap cooling unit, rooftop packaged unit, split air conditioning evaporator sections 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 EOR for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC 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 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum and heating set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses. Isolation room supply air valves are similar.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at the heating airflow and adjust controller or regulator to deliver the designed airflow.
6. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

7. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

8. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
9. Record final fan-performance data.

3.7 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.

3.8 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 EOR and comply with requirements in Section 232123 "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 presetting's.

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.

3.9 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.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

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 BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Thermal Fluid Steam System: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow. Check the pressure reducing stations settings.

3.14 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.
5. Steam condensate 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.

3.15 SOUND TESTS

A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at 15 locations as designated by the Architect.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (LEQ).
3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.

5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inches (900 mm) from a wall or from the operating equipment and approximately 60 inches (1500 mm) from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:

   a. Location.
   b. System tested.
   c. dBA reading.
   d. Sound pressure level in each octave band with equipment on and off.

2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.16 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 5.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.

4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.17 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.18 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.19 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 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 5 percent.

3.20 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 monthly 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.

3.21 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. Settings for supply-air, static-pressure controller.
    g. 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. VFD size, make and model
c. Horsepower and rpm.
d. Volts, phase, and hertz.
e. Full-load amperage and service factor.
f. Sheave make, size in inches, and bore.
g. 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. Cooling-coil static-pressure differential in inches wg.
g. Heating-coil static-pressure differential in inches wg.
h. Outdoor airflow in cfm.
i. Return airflow in cfm.
j. Outdoor-air damper position.
k. Return-air damper position.
l. 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 (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).

f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

G. Gas-Fired Boiler Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h (kW).
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches (mm), and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btu/h (kW).
i. High-fire fuel input in Btu/h (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).
l. Operating set point in Btu/h (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h (kW).

H. 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 (mm), and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

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 (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
g. Number, make, and size of belts.
h. VFD type, make and model

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

I. Round 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 (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated air flow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual air flow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).

k. Barometric pressure in psig (Pa).

J. 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. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary air flow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

K. System-Coil Reports: For reheat 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 (L/s).
b. Water flow rate in gpm.
c. Entering-water temperature in deg F (deg C).
d. Leaving-water temperature in deg F (deg C).
e. Water pressure drop in feet of head or psig (kPa).
f. Entering-air temperature in deg F (deg C).
g. Leaving-air temperature in deg F (deg C).

L. 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 (L/s).
    g. Water pressure differential in feet of head or psig (kPa).
    h. Required net positive suction head in feet of head or psig (kPa).
    i. Pump rpm.
    j. Impeller diameter in inches (mm).
    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.
    q. VFD type make and model.

2. Test Data (Indicated and Actual Values):

    a. Static head in feet of head or psig (kPa).
    b. Pump shutoff pressure in feet of head or psig (kPa).
    c. Actual impeller size in inches (mm).
    d. Full-open flow rate in gpm (L/s).
    e. Full-open pressure in feet of head or psig (kPa).
    f. Final discharge pressure in feet of head or psig (kPa).
    g. Final suction pressure in feet of head or psig (kPa).
    h. Final total pressure in feet of head or psig (kPa).
    i. Final water flow rate in gpm (L/s).
    j. Voltage at each connection.
    k. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:

    a. Instrument type and make.
    b. Serial number.
    c. Application.
    d. Dates of use.
    e. Dates of calibration.

3.22 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.
    b. Measure water flow of at least 5 percent of terminals.
    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 EOR and Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of EOR and Commissioning Authority.
3. EOR and 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.

3.23 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 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Outdoor, exposed supply and return.
6. Outdoor mounted sound attenuators.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

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

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

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

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

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

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

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

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

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

G. 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 FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

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

2.2 ADHESIVES

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

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

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

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

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

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

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

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

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

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

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
b. Eagle Bridges - Marathon Industries; 501.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
d. Mon-Eco Industries, Inc.; 55-10.

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

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

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.

3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

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

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.

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

2.4 LAGGING ADHESIVES

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

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   b. Vimasco Corporation; 713 and 714.

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

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

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

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

C. Metal Jacket:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless-Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

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

a. Sheet and roll stock ready for shop or field sizing or 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.

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

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

a. Polyguard Products, Inc.; Alumaguard 60.
b. Metro Supply Company: FlexClad 400

2.8 TAPES

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

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

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

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

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

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

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.

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

2.9 SECUREMENTS

A. Bands:

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

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

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015-inch-thick, 3/4-inch-wide with wing seal 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. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

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

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

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

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

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

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low-carbon steel or stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

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

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

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

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

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C & F Wire.
b. Equal.

2.10 CORNER ANGLES

A. Stainless-Steel Corner Angles: 0.024-inch-thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

B. Provide insulation and aluminum jacketing over sound attenuators mounted on the building roof.

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

D. 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.

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

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

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.

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. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

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

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

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.

3.4 PENETRATIONS

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

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

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

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

4. Seal jacket to wall flashing with flashing sealant.

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: 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 Section 078413 "Penetration Fire-stopping" and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: 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. Seal penetrations through fire-rated assemblies.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. 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.

3.6 FINISHES

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

3.7 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

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

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

3.8 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 located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Outdoor mounted sound attenuators.

B. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density to achieve a minimum performance value of R-4.2

B. Concealed, round return-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density to achieve a minimum performance value of R-4.2

C. Concealed, rectangular, supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density to achieve a minimum performance value of R-4.2

D. Concealed, rectangular, return-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density to achieve a minimum performance value of R-4.2

E. Concealed, supply-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density to achieve a minimum performance value of R-4.2

F. Concealed, return-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density to achieve a minimum performance value of R-4.2

3.10 OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below:
   1. Internally line the exposed outside the building ductwork with 2 inches thick and 3-lb/cu. ft. nominal density to achieve a minimum performance value of R-8. acoustical internal duct liner.
      a. Products: Subject to compliance with requirements, provide one of the following:

         John Manville; Linacoustic RC Duct Liner
         Owens Corning; Quiet R, Rotary Duct Liner
         Knauf; Sonic XP Duct Liner

B. Exposed, rectangular, sound traps insulation shall be the following:
   1. Mineral-Fiber Blanket: 2 inches thick and 6-lb/cu. ft. nominal density to achieve a minimum performance value of R-8.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. Ducts and Plenums, Concealed:

   1. None.

C. Ducts and Plenums, Exposed:

   1. None.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install aluminum jacket over 2” rigid insulation material for the sound attenuators. Provide insulation with factory-applied jacket, install the field-applied aluminum jacket over the factory-applied jacket.

B. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. Painted Aluminum, Smooth: 0.020 inch thick.

C. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

   1. Painted Aluminum, Smooth with 4-by-1-Inch Box Ribs: 0.040 inch thick.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Heating, hot-water pumps.
   2. Expansion tanks.
   3. Air separators.

B. Related Sections:

   1. Section 230713 "Duct Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

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

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

   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail removable insulation at equipment connections.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.
   5. Detail field application for each equipment type.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

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

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

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

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

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

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
b. Rock Wool; Delta Board.
c. Roxul Inc.; RHT and RockBoard.
d. Thermafiber, Inc.; Thermafiber Industrial Felt.

2. Products: Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ.

G. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

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

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

a. Ramco Insulation, Inc.; Super-Stik.
b. Equal.

2.3 ADHESIVES

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

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

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

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

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2.4 MASTICS

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

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

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

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

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.

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

2.5 SEALANTS

A. Joint Sealants:

B. FSK and Metal Jacket Flashing Sealants:

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

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

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

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.

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

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2) Equal.

2.7 FIELD-APPLIED JACKETS

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

B. Metal Jacket:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

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

a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 2.5-mil thick polysurlyn.
d. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-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.

C. 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 stucco-embossed aluminum-foil facing.

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

a. Polyguard Products, Inc.; Alumaguard 60.
b. Equal.

2.8 TAPES

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

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

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

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

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

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

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

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

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

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

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.

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

6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Products:

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

2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing 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, 0.135-inch diameter shank, length to suit depth of insulation indicated.

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

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

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

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

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

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

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

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

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

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

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

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

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

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C & F Wire.
b. Equal.

2.10 CORNER ANGLES

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

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

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

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

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

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

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

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

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

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

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholds.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire

ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

3.5 FIELD-APPLIED METAL JACKET INSTALLATION

A. 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.

3.6 FINISHES

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

3.7 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

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

3.8 FLUE VENTS INSULATION SCHEDULE

A. Round, exposed flue vents and the noise suppressors insulation shall be the following:
   1. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

3.9 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heating-hot-water pump insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches 6-lb/cu. ft. nominal density.
   2. Mineral-Fiber Pipe and Tank: 2 inches thick.

D. Heating-hot-water expansion tank insulation shall be the following:
   1. Mineral-Fiber Board: 2-inch-thick and 6-lb/cu. ft. nominal density.

E. Heating-hot-water air-separator insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied metal jacket over the factory applied jacket on all exposed pipe and equipment.

B. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied metal jacket over the factory applied jacket on all pipe and equipment located in accessible trenches below floor.

C. Equipment, Concealed:

   1. None.

3.11 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches;

1. Painted Aluminum, Smooth with Z-Shaped Locking Seam: 0.040 inch thick.

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

1. Painted Aluminum, Smooth with 4-by-1-Inch Box Ribs: 0.040 inch thick.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors and outdoors.
2. Heating hot-water piping, indoors and outdoors.
3. Steam and steam condensate piping, indoors and outdoors.
4. Refrigerant suction and hot-gas piping, indoors and outdoors.
5. Heated fuel-oil piping, outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230716 "HVAC Equipment Insulation."

1.3 ACTION SUBMITTALS

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

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties.
5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

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

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

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

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

F. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

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

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

a. Ramco Insulation, Inc.; Super-Stik.
b. Equal.

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

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

a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
b. Equal.

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

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

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

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

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

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

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

   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

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

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

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
   b. - Marathon Industries; 570.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

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

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.

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

2.5 LAGGING ADHESIVES

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

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   c. Vimasco Corporation; 713 and 714.

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

2.6 SEALANTS

A. Joint Sealants:

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, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

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

5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants:

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Equal.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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 JACKETS

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

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

C. Metal Jacket:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

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

a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 2.5-mil thick polysurlyn.
d. Moisture Barrier for Outdoor Applications: 2.5-mil thick polysurlyn.
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.

2.9 TAPES

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

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

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

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

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

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

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

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

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

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

    a. ABI, Ideal Tape Division; 488 AWF.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    c. Compac Corporation; 120.
    d. Venture Tape; 3520 CW.

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

2.10 SECUREMENTS

A. Bands:

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

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

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
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. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

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

   a. C & F Wire.
   b. Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
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. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

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

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

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

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

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

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

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

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. 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 Section 078413 "Penetration Firestopping" for 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 Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining

pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

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

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

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

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

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe 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.

C. 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. 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.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

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

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

3.9 FINISHES

A. Pipe Insulation with ASJ, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

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

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

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

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

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

3.10 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.11 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.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 12 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

C. Steam and Steam Condensate, 350 Deg F and Below:

1. NPS 3/4 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches thick.

2. NPS 1 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II or Pipe and Tank Insulation: 3 inches thick.

D. Steam and Steam Condensate, above 350 Deg F:

1. NPS 3/4 and Smaller: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches thick.

2. NPS 1 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II or Pipe and Tank Insulation: 3 inches thick.

E. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 1 inch thick.

F. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

   a. Flexible Elastomeric: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

B. Steam and Steam Condensate, 350 Deg F and Below:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 3 inches thick.

C. Steam and Steam Condensate, above 350 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 4 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 2 inches thick.

E. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

F. Fuel Oil Piping, Heated:

1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Concealed:

1. None.

D. Piping, Exposed or in a trench:
1. Aluminum, Smooth: 0.040 inch thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Exposed:
1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.040 inch thick.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

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 commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final

testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R systems, subsystems, and equipment Testing Procedures

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of oil, gas, steam and hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems, environmental exhaust; and other distribution systems, including HVAC&R terminal equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 230800

SECTION 230923 - DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1: GENERAL

1.1 WORK INCLUDED

A. Furnish a totally native BACnet-based system, including a Microsoft Windows 8 or Windows 10 compatible operator's workstation. The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2008, BACnet. In other words, all workstations and controllers, including unitary controllers, shall be native BACnet MSTP or BACnet IP devices. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections.

B. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

H. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new electronic actuators. No

used components shall be used as any part or piece of installed system.

M. Include as an added bid item the cost of the service contract for the remote monitoring of all BMS controlled systems in the building.

N. Include as an added bid item the cost of the scheduling modifications and refinement with the tenant.

1.2 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2008, BACnet and achieved listing under the BACnet Testing Laboratories BACnet - Advanced Workstation Software (B-AWS). This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, AC units, etc., and all air handlers, boilers, lighting control panels, UPS, generators, building elevators, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. Provide integration to the lighting system through BACnet IP protocol so the lighting can be scheduled through the DDC system and include graphics that show whether lights are on or off on the floor plans. The DDC system shall be able to interface with the lighting control panel to facilitate scheduling, automatic daylight saving time adjustments, etc.

C. Operator's workstation software shall use Microsoft Windows 8 or Windows 10 as the computer operating system. The Direct Digital Control system (DDC) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. All software required to program application specific controllers and all field level devices and controllers will be left with the owner. All software passwords required to program and make future changes to the system will also become the property of the owner. All software required to make any program changes anywhere in the system, along with scheduling and trending applications, will be left with the owner. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner. All software required for all field engineering tools including graphical programming and applications will be left with the owner. All software passwords required to program and make future changes to field engineering tools, including graphical programming and applications will be left with the owner.

D. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used

for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

E. Room sensors shall be provided with digital readout that allows the user to view room temperature and humidity, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

F. All application controllers for every terminal unit (VAV, FCU, etc.) air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet MSTP.

1.3 APPROVED MANUFACTURERS

A. The base bid shall be the Alerton Compass system.

1.4 QUALITY ASSURANCE

A. The Building Automation System (BAS) system shall be designed, installed, commissioned, and serviced by manufacturer authorized and trained personnel. System provider shall have an in-place support facility within 2 hours' response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

The contractor shall provide full-time, on-site, experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the design, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

B. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

E. Control system shall be engineered, programmed and supported completely by representative's local office that must be within 100 miles of project site.

1.5 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

2. ANSI/ASHRAE Standard 135-2008, BACnet.

3. Uniform Building Code (UBC), including local amendments.

4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.

5. National Electrical Code (NEC).

6. FCC Part 15, Subpart J, Class A.

7. EMC Directive 89/336/EEC (European CE Mark).

8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.6 SUBMITTALS

A. Drawings

1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.

2. Drawings shall be submitted in the following standard sizes: 11” x 17” (ANSI B).

3. Eight complete sets (copies) of submittal drawings shall be provided.

4. Drawings shall be available on CD-ROM.

B. System Documentation

Include the following in submittal package:

1. System configuration diagrams in simplified block format.

2. All input/output object listings and an alarm point summary listing.

3. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.

4. Complete bill of materials, valve schedule and damper schedule.

5. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.

6. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.

7. For all system elements—operator's workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.

8. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.

9. A list of all functions available and a sample of function block programming that shall be part of delivered system.

C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

1.7 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours, Monday through Friday and 48 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

1.8 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. Refer to Section 23 00 00 for General Mechanical Provisions.

C. Refer to Section 26 00 00 for General Electrical Provisions.

PART 2: PRODUCTS

2.1 OPERATOR'S WORKSTATION

A. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients

shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 simultaneous clients.

B. BACnet Conformance

1. Operator Work Station shall be approved by the BTL as meeting the BACnet Advanced Work Station requirements.

2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types accessed by the workstation shall include as a minimum: Analog Value, Analog Input, Analog Output, Binary Value, Binary Input, Binary Output, Calendar, Device, Event Enrollment, File, Notification Class, Program, and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

4. The operator's workstation shall comply with Annex J of the BACnet specification for IP connections. Must support remote connection to server using a thick client application. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs). Workstation shall support Foreign Device Registration to allow temporary workstation connection to IP network.

C. Displays

1. Operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display all data using three-dimensional graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Workstation shall allow user to change all field-resident EMCS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

2. All displays and programming shall be generated and customized by the local EMCS supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.

3. Binary objects shall be displayed as ACTIVE/INACTIVE/NULL or with customized text such as Hand-Off-Auto. Text shall be justified left, right or center as selected by the user. Also, allow binary objects to be displayed as individual change-of-state graphic objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three graphic files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the object's commanded status when the graphic item is selected with the system mouse. Similarly, allow the workstation operator to toggle the binary object's status by selecting with the mouse, for example, a graphic of a switch or light, which then displays a different graphic (such as an "ON" switch or lighted lamp. Additionally, allow binary objects to be displayed as an animated graphic. Animated graphic objects shall be displayed as a sequence of multiple graphics to simulate motion. For example, when a pump is in the OFF condition, display a stationary graphic of the pump. When the operator selects the pump graphic with the mouse, the represented object's status is toggled and the graphic of the pump's impeller rotates in a time-based animation. The operator shall be able to click an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change graphic file assignment and also create new and original graphics online. System shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.

4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic. Each analog input object may be assigned a minimum of five graphic files, each with high/low limits for automatic selection and display of these graphics. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the "increase" or "decrease" arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trendlogs.

5. Analog objects may also be assigned to a system graphic, where the color of the defined object changes based on the analog object's value. For example, graphical thermostat device served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified online using simple icon tools.

6. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label pushbuttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not

appear on the graphic if the operator does not have the appropriate security level.

7. The BAS displays shall have the ability to link to content outside of the BAS system. Such content shall include but is not limited to: Launching external files in their native applications (for example, a Microsoft Word document) and launching a Web browser resolving to a specified Web address.

8. The BAS system shall have the ability to run multiple, concurrent displays windows showing continuously updated data.

9. Graphic items with custom geometry that offer both color gradient shading and variable opacity in scale to system variables and range setpoints (OmniGraphics). Ability to automatically resize to display (OmniZoom).

D. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.

2. Each operator's terminal shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long. Each system user shall be allowed individual assignment of only those control functions, menu items, and user specific system start display, as well restricted access to *discrete BACnet devices* to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Users should have the capability to be assigned to specific user type "groups" that can share the same access levels to speed setup. Users who are members of multiple "groups" shall have the ability to activate/deactivate membership to those groups while using the BAS (without logout). Users shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.

3. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

4. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

E. Operator Activity Log

1. Operator Activity Log that tracks all operator changes and activities shall be included with system. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort

the changes by user and also by operation. Operator shall be able to print the Operator Activity log display.

2. Log shall be gathered and archived to hard drive on operator's workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

3. Any displayed data that is changeable by the operator may be selected using the right mouse button and the operator activity log shall then be selectable on the screen. Selection of the operator activity log using this method shall show all operator changes of just that displayed data.

F. Scheduling

1. Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.

2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.

3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

4. System shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting Schedule.

5. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

7. Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule or launch the Schedule Wizard to allow the point to be scheduled.

G. Alarm Indication and Handling.

1. Operator's workstation shall provide audible, visual, printed, and email means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.

2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

3. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).

4. System shall include an Alarm Wizard for set up of alarms. Wizard shall walk user through all steps necessary for alarm generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting alarm setup.

5. Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or launch the Alarm Wizard to allow the creation of a new alarm.

H. Trendlog Information

1. System server shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the operator's workstation. Operator shall be able to view all trended records, both stored and archived. All trendlog records shall be displayed in standard engineering units.

2. Software that is capable of graphing the trend logged object data shall be included. Software shall be capable of creating two-axis (X, Y) graphs that display up to 10 object types at the same time in different colors. Graphs shall show object values relative to time. Each trendlog shall support a custom scale setting for the graph view that is to be stored continuously. System shall be capable of trending on an interval determined by a polling rate, or change-of-value.

3. Operator shall be able to change Trendlog setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.

4. System shall include a Trend Wizard for setup of logs. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right-clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

5. System shall be capable of using Microsoft SQL as the system database.

6. Any displayed data that is changeable by the operator may be selected using the right mouse button and the trendlog shall then be selectable on the screen. Selection of the trendlog using this method shall allow the viewing of the trendlog view or launch the Trendlog wizard to allow the creation of a new trend.

I. Energy Log Information

1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.

2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.

3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.

4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

J. Demand Limiting

1. System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.

2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.

3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.

4. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an

individual shed program shall be displayed along with English description of each load.

L. Reports

1. System server shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.

2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

M. Configuration/Setup

1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

N. Field Engineering Tools

1. Operator's workstation software shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.

2. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.

3. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.

4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.

5. Field engineering tool shall include Device Manager for detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller using the mouse.

6. System shall automatically notify the user when a device that is not in the database is added to the network.

7. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.

8. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

O. Workstation Hardware

1. Provide operator's workstation(s) at location(s) noted on the plans.

2. Workstation/server computer minimum requirements

a. PC Processor of 2.5 GHz quad-core or better

b. 8 GB RAM or better

c. 1TB hard disk or better

d. High-performance graphics adapter

e. Ethernet 10/100 network interface card

f. Keyboard, monitor, mouse, USB port and CD-ROM

g. Microsoft Windows 8 or Windows 10

h. Monitor size shall be 22" minimum

i. Color printer (inkjet, color dye or laser)

P. Software

1. At the conclusion of project, contractor shall leave with owner a CD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner how to completely restore the system in the case of a computer malfunction.

2.2 GRAPHICAL USER INTERFACE

A. Display of Data

1. Graphics displays shall include animation of all Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.

2. Real-time data shall be shown. This data must be directly gathered using the BACnet network and automatically updated without any user action.

3. It shall be possible for user to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change

digital data. Using pull-down menus or typing in a new value shall change analog data.

4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display.

B. Time Schedule Adjustment

1. Logged in access shall allow user to view and edit all schedules in the system. This includes standard, holiday and event schedules as described in BAS specification. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.

2. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.

3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

C. Logging of Information

User shall use standard browser technology to view all trendlogs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust Y axis of data viewed in graphical format. Data shall be in CSV format.

D. Alarm Handling

The front end shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user-selected time frame. In addition, those alarms may be filtered for viewing per user-selected options. A single selection shall display all alarms that have not been acknowledged.

E. BACnet Communication

The Alerton system shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

2.3 BUILDING CONTROLLER

A. General Requirements

1. BACnet Conformance

a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.

b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2. Building controller shall be of modular construction such that various modules may be selected to fit the specific requirements of a given project. At a minimum, modules shall consist of a power supply module, a BACnet Ethernet-MS/TP (master slave token passing) module, a BACnet MS/TP-only module, and a modem module for telephone communication. Those projects that require special interfaces may use Modbus modules as needed. However, all Ethernet communications and all controllers—including central plant controllers, advanced application controllers and unitary controllers—supplied by BAS manufacturer shall utilize the BACnet protocol standard.

3. Modules shall be selected to fit the particular project application. Up to seven modules shall be powered by a single power supply module. All modules shall be panel-mounted on DIN rail for ease of addition and shall be interconnected using a simple plug-in cable. A module in the middle shall be replaceable without removing any other modules.

4. All modules shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller. The software program implementing these strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a WAN or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.

5. Programming shall be object-oriented using control function blocks, and support DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.

6. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.

7. Controller shall have sufficient memory to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery backup shall maintain real-time clock functions for a minimum of 20 days.

8. Global control algorithms and automated control functions shall execute using 32-bit processor.

9. Schedules

10. Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.

11. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.

12. Logging Capabilities

    a. Each building controller shall log as minimum 320 values. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

    b. Logs may be viewed both on-site or off-site using WAN or remote communication.

    c. Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.

    d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

13. Alarm Generation

    a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

    b. Each alarm may be dialed out as noted elsewhere.

    c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

    d. Controller must be able to handle up to 320 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

14. Demand Limiting

    a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.

    b. Load shedding programs in building controller modules shall operate as defined in section 2.1.J of this specification.

15. Tenant Activity Logging

a. Tenant Activity logging shall be supported by building controller module. Each independent module shall support a minimum of 80 zones.

b. Tenant Activity logging shall function as defined in section 2.1.K of this specification.

B. Ethernet – MS/TP Module

1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.

2. All communication with operator's workstation and all application controllers shall be through BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet – MS/TP module shall also route messages from all other building controller modules onto the BACnet Ethernet network.

a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.

b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).

3. BACnet Conformance

a. Ethernet – MS/TP module shall, as a minimum, support MS/TP and Ethernet BACnet LAN types. It shall communicate directly using these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Global controller shall be approved by the BACnet Testing Laboratory (BTL) as meeting the BACnet Building Controller requirements.

b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

c. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on WANs and CANs and function as a BACnet Broadcast Management Device (BBMD).

C. MS/TP Module

1. MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.

2. Building controller MS/TP module communications shall be though BACnet MS/TP LAN to all advanced application and application-specific controllers. MS/TP module shall also route messages to Ethernet - MS/TP module for communication over WAN.

a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps

b. Configuration shall be through RS-232 connection.

3. BACnet Conformance

a. MS/TP module shall be approved by the BTL (BACnet Testing Laboratory) as meeting the BACnet Building Controller requirements. MS/TP module shall as a minimum support MS/TP BACnet LAN type. It shall communicate directly using this BACnet LAN as a native BACnet device and shall support simultaneous routing functions between all supported LAN types.

b. Standard BACnet object types supported shall include, as a minimum, Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program, and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

F. Power Supply Module

1. Power supply module shall power up to seven building controller modules. Input for power shall accept between 17–30VAC, 47–65Hz.

2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.

2.4 AIR HANDLER APPLICATION CONTROLLERS

A. Provide one or more native BACnet application controllers for each air handler and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller through either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. BACnet Conformance

1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.

2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input,

Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.

2. The position of each and every HOA switch shall be available system wide as a BACnet object property.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal.

1. The following control blocks shall be supported:

a. Natural Log

b. Exponential

c. Log base 10

d. X to the power of Y

e. Nth square root of X

f. 5th Order Polynomial Equations

g. Astronomical Clock (sunrise/sunset calculation)

h. Time based schedules

E. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic

sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

F. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

G. Schedules

1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time clock on board with battery backup to maintain time through a power loss.

H. Logging Capabilities

1. Controller shall support a minimum of 50 trendlogs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

I. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.

2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

J. The controller processor shall be a 32-bit processor.

K. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.5 TERMINAL UNIT APPLICATION CONTROLLERS (Fan-Coils)

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. BACnet Conformance

1. Application controllers shall, as a minimum, support MS/TP BACnet LAN types. They shall communicate directly using this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:

   a. Files Functional Group

   b. Reinitialize Functional Group

   c. Device Communications Functional Group

2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.6 VAV BOX CONTROLLERS—SINGLE DUCT WITH HOT WATER REHEAT

A. Provide one native BACnet application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. BACnet Conformance

1. Application controllers shall, at a minimum, support MS/TP BACnet LAN types. They shall communicate directly through this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements.

2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure-independent control algorithms and all flow readings shall be in CFM (LPS if metric).

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using the same programming tool as Building Controller and as described in operator's workstation section. All programming tools shall be provided as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at application controller and

include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operations for specific display requirements for intelligent room sensor.

F. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator's workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.

G. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator's workstation.

2.7 AUXILIARY CONTROL DEVICES

A. Temperature Sensors

1. All temperature sensors to be solid-state electronic, interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake, and in a location that is in the shade most of the day.

B. Intelligent Room Sensor with LCD Readout

1. All room sensors shall be a combination temperature and humidity sensor and integrated Co2 where shown on the floor plans. The sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.

2. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.

3. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list.

4. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

C. Wall Sensor

1. Standard wall sensor shall use solid-state sensor identical to intelligent room sensor and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide override function, warmer/cooler lever for set point adjustment and port for plug-in of Field Service Tool for field adjustments. Override time shall be stored in controller and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller. All programmable variables shall be available to field service tool through wall sensor port.

E. Airflow Control:

1 Provide airflow measuring stations and control for the roof mounted air handling unit.
2 A factory-furnished and calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.
3 The controller and actuator shall communicate to control the desired airflow.
4 The controller shall receive a zero- to 10-V dc input signal and report a zero- to 20-mA output signal that is proportional to the airflow.
5 Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm (0.8 to 10 m/s).
6 Ambient Operating Temperature Range: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
7 Ambient Operating Humidity Range: 5 to 95 percent relative humidity, non-condensing.
8 Provide unit with control transformer rated for not less than 85 VA. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
9 Provide screw terminals for interface to field wiring.
10 Factory mount electronics within a NEMA 250, Type 1 painted steel enclosure.

F. THERMAL ENERGY METERS

1 Performance Requirements: Manufacturer shall certify that each energy meter indicated complies with specified performance requirements and characteristics.

a. Product certificates are required.

Insertion-Type Thermal Energy Meters:

b. Manufacturer: Subject to compliance with requirements, provide products by the following:

ONICON Incorporated Turbine Flow Meter Model F-1210 and BTU Meter Model System-10-BAC.

c. Description:

1) Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, keypad user interface, installation hardware, color-coded interconnecting cabling, and installation instructions.
2) Each thermal energy meter shall be individually calibrated and provided with calibration certification traceable to NIST.

d. Alphanumeric display of the following on face of enclosure:

1) Total energy consumption.
2) Energy rate.
3) Flow rate.
4) Supply temperature.
5) Return temperature.
6) Visual indication of power status (on/off) on face of enclosure.

e. Electronics Enclosure:

1) Remote from temperature and flow sensors.
2) NEMA 250, Type 12 or Type 13 for indoor applications and NEMA 250, Type 4 or Type 4X for outdoor applications.
3) Labeled terminal strip for field wiring connections.

f. Programming:

1) Factory programmed for specific application and field programmable through keypad on face of enclosure.
2) Programmed parameters and total energy consumption shall be stored in non-volatile EEPROM memory.

g. Output Signals:

1) Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50-V rating and contact duration of 0.5, 1, 2, or 6 seconds.
2) Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero- to 10-V dc for each.

h. Temperature Sensors:

1) Temperature range matched to application.
2) Temperature accuracy within 0.15 deg F (0.08 deg C) over the calibrated range.
3) Stainless-steel or brass thermowell with NPS 1/2 (DN 15) NPT connection for each sensor.

i. Current Sensors:

1) Veris Model H-908 or equal.

j. Differential Pressure Transmitters & Switches:

1) Duct Static Pressure shall be Dwyer Model MS2-D102 or equal.
2) Space Static Pressure shall be Dwyer Model MS2-W111 or equal.
3) Hydronic Differential Pressure shall be Dwyer Model 629-05-CH-P2-E5-51-3V or equal.
4) Filter Switches shall be Dwyer Model ADPS-04-1-N or equal.

2.8 ELECTRONIC ACTUATORS AND VALVES

A. Quality Assurance for Actuators and Valves

1. UL Listed Standard 873 and C.S.A. Class 4813 02 certified.

2. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.

3. Five-year manufacturer's warranty. Two-year unconditional parts and labor and three-year product defect from date of installation.

B. Execution Details for Actuators and Valves

1. Furnish a Freeze-stat and install "Hard Wire" interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.

2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status.

3. VAV box damper actuation shall be floating type or analog (2–10VDC or 4–20mA).

4. Booster-heat valve actuation shall be floating type or analog (2-10VDC 4-20mA).

5. Primary valve control shall be analog (2–10VDC or 4–20mA).

C. Actuators for damper and control valves 0.5–6 inches shall be electric unless otherwise specified, provide actuators as follows:

1. UL Listed Standard 873 and Canadian Standards Association Class 481302 shall certify actuators.

2. NEMA 2 rated actuator enclosures for inside mounting. Use additional weather shield to protect actuator when mounted outside.

3. Five-year manufacturer's warranty. Two-year unconditional and three-year product defect from date of installation.

4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

5. Position indicator device shall be installed and made visible to the exposed side of the actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the actuator.

6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for butterfly valve actuators.

7. A Pushbutton gearbox release shall be provided for all non-spring actuators.

8. Modulating actuators shall be 24VAC and consume 10VA power or less.

9. Conduit connectors are required when specified and when code requires it.

D. Damper Actuators:

1. Outside air and exhaust air damper actuators shall be mechanical spring return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.

2. Economizer actuators shall utilize analog control 2–10VDC. Floating control is not acceptable.

3. Electric damper actuators (including VAV box actuators) shall be direct shaft-mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or set-screw type fasteners are not acceptable.

4. One electronic actuator shall be direct shaft-mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.

5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft-mounted per damper section. (See below execution section for more installation details.)

E. Valve Actuators 0.5–6 inches

1. Mechanical spring shall be provided on the actuator for AHU cooling coil bank, when units are mounted outside. See plans for fail-safe flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

2. All zone VAV box reheat coil service actuators shall be non-spring return, unless otherwise specified.

3. The valve actuator shall be capable of providing the minimum torque required for proper valve close-off for the required application.

4. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.

5. Override handle and gearbox release shall be provided for all non-spring return valve actuators.

F. Control Valves 0.5–6 inches

1. The contractor shall furnish all motorized control valves and actuators, shall furnish all control wiring to actuators and shall install all valves. Equal percentage control characteristic shall be provided for all water coil control valves.

2. Characterized control valves shall be used for hydronic heating or cooling applications and small to medium AHU water-coil applications to 200 GPM. Cooling tower coil control valves shall be for water-coil applications up to 550 GPM Actuators are non-spring return for terminal unit coil control unless otherwise noted. If the coil is exposed to the outside air stream, see plans for spring return requirement.

   a. Leakage is aero percent, close-off is 200psi, maximum differential is 30psi; rangeability is 500:1.

   b. Valves 0.5–2 inches shall be nickel-plated forged brass body, NPT screw type connections.

   c. Valves 0.5–1.25 inches shall be rated for ANSI Class 600 working pressure. Valves over 1.5 inches shall be rated for ANSI Class 400 working pressure. Two-position control valves shall be line size.

   d. The operating temperature range shall be 0–250 degrees F.

   e. Stainless steel ball and stem shall be furnished on all modulating valves.

   f. Seats shall be fiberglass reinforced Teflon.

   g. Two-way and three-way valves shall have an equal percentage control port. Full stem rotation is required for maximum flow to insure stable BTU control of the coil.

   h. Three-way valve shall be applicable for both mixing and diverting.

   i. The characterizing disc is made of TEFZEL and shall be keyed and held secure by a retaining ring.

   j. The valves shall have a blow-out proof stem design.

   k. The stem packing shall consist of 2 lubricated O-rings designed for on-off or modulating service and require no maintenance.

   l. The valves shall have an ISO type, 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe.

   m. A non-metallic thermal isolation adapter shall separate valve flange from

actuator.

n. One fastening screw shall secure the direct coupling of the thermal isolation adapter between the actuator and the valve. This will prevent all lateral or rotational forces from affecting the stem and its packing O-rings.

G. Butterfly valves

1. Butterfly valves shall be sized for modulating service at 60–70-degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 10 feet per second when used with standard EPDM seats.

a. Body is cast iron.

b. Disc is aluminum bronze standard.

c. Seat is EPDM standard.

d. Body Pressure is 200 psi, -30–275 degrees F.

e. Flange is ANSI 125/250.

f. Media Temperature Range is -22–240-degree F.

g. Maximum Differential Pressure is 200 psi for 2- to 6- inch size.

H. Butterfly Valve Industrial Actuators

1. Actuators shall be approved under Canadian Standards Association or other Nationally Recognized Testing Laboratory to UL standards. CSA Class 4813 02 or equal. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.

a. Actuator shall have motor rated for continuous duty. The motor shall be low voltage type. Two adjustable cam-actuated end travel limit switches shall be provided to control direction of travel.

b. Reduction gearing shall be designed to withstand the actual motor stall torque.

c. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.

d. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.

e. The actuator shall be analog, floating, or two position as called out in the control sequence of operation. All Analog valves shall be positive positioning, and respond to a 2–10VDC, 4-20mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.

2. Performance Verification Test

   a. Control loops shall cause productive actuation with each movement of the actuator and actuators shall modulate at a rate that is stable and responsive. Actuator movement shall not occur before the effects of previous movement have affected the sensor.

   b. Actuator shall have capability of signaling a trouble alarm when the actuator Stop-Go Ratio exceeds 30%.

3. Actuator mounting for damper and valve arrangements shall comply with the following:

   a. Damper actuators: Shall not be installed in the air stream

   b. A weather shield shall be used if actuators are located outside. For damper actuators, use clear plastic enclosure.

   c. Damper or valve actuator ambient temperature shall not exceed 122 degrees F through any combination of medium temperature or surrounding air. Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary.

   d. Actuator cords or conduit shall incorporate a drip leg if condensation is possible. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator.

   e. Damper mounting arrangements shall comply with the following:

      1. The contractor shall furnish and install damper channel supports and sheet metal collars.

      2. No jack shafting of damper sections shall be allowed.

      3. Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.

4. Valve Sizing for Water Coil

   b. Modulating control valve body size may be reduced, at most, two pipe sizes from the line size or not less than half the pipe size. The BAS contractor shall size all water coil control valves for the application as follows:

1. Primary valves shall be sized not to exceed 5–8psi differential pressure. Size valve for 50% valve authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.

2. Butterfly valves shall be sized for modulating service at 60–70-degree rotation. Design velocity shall be 10 feet per second or less when used with standard EPDM seats.

c. Valve mounting arrangements shall comply to the following:

1. Unions shall be provided on all ports of two-way and three-way valves.

2. Install three-way equal percentage characterized control valves in a mixing configuration with the “A” port piped to the coil.

3. Install 2.5 inches and above, three-way globe valves, as manufactured for mixing or diverting service to the coil.

2.9 CONTROL PANELS

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall have hinged, locking doors.

D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

E. Control panels must be assembled by a UL authorized fabricator in accordance with UL508A standards and labeled with separate UL label numbers.

PART 3: EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the owner’s representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

3.2 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

C. Provide 3-way control valves for all reheat coils indicated as such in the VAV box schedule.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3 feet of clear access space in front of units. Obtain approval on locations from owner's representative prior to installation.

B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

C. Identify all equipment and panels. Provide permanently mounted tags for all panels.

D. Provide stainless steel thermowells on chilled water piping and brass thermowells on heating hot water system piping and sized to suit pipe diameter without restricting flow.

Install coil hookup assembly within 12 inches above ceiling for easy maintenance.

3.4 INTERLOCKING AND CONTROL WIRING

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate with electrical contractor.

F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum-rated cable (without conduit).

3.5 DDC OBJECT TYPE SUMMARY

A. Provide all database generation.

B. Displays

1. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air

temperature indication on all system displays associated with economizer cycles.

C. Run Time Totalization

1. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.

D. Trendlog

1. All binary and analog object types (including zones) shall have the capability to be automatically trended.

E. Alarm

1. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.

F. Database Save

1. Provide backup database for all standalone application controllers on disk.

3.6 FIELD SERVICES

A. Prepare and start logic control system under provisions of this section.

B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.

D. Provide owner's representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.7 AS-BUILT DOCUMENTATION REQUIRED

A. Complete set of accurate control drawings and programming.

3.8 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of three persons.

C. Provide on-site training above as required, up to 16 hours as part of this contract.

D. Provide tuition for at least two individuals to attend for a two-day factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the owner.

3.9 DEMONSTRATION

A. Demonstrate complete operating system to owner's representative.

B. Provide certificate stating that control system has been tested and adjusted and commissioned for proper operation.

END OF SECTION 230923

SECTION 23 1123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
2. Service Regulators: 100 psig (690 kPa) minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 10 psig (69 kPa).

B. Natural-Gas System Pressure within Buildings: Between 0.5 psig (3.45 kPa) and 5 psig (34.5 kpa).

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

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

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings.
6. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot (1:50).
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

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

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Qualification Data: For qualified professional engineer.

D. Current welding certificates.

E. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

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

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

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.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

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

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.10 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.

2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.11 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Cathodic Protection for Underground Piping: Contractor shall design and install cathodic protection for the new piping as follows:

    a. Utilize bracelet type anods.

7. Mechanical Couplings:

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

1) Dresser Piping Specialties; Division of Dresser, Inc.
2) Smith-Blair, Inc.

b. Steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Steel bolts, washers, and nuts.
e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

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

a. OmegaFlex, Inc.
b. Parker Hannifin Corporation; Parflex Division.
c. Titeflex.
d. Tru-Flex Metal Hose Corp.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig (34.5 kPa).

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated, and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or flanged or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated, and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Outlet shall be threaded or flanged or suitable for welded connection.
    c. Bridging sleeve over mechanical coupling.
    d. Factory-connected anode.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

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

        1) Dresser Piping Specialties; Division of Dresser, Inc.
        2) Smith-Blair, Inc.

    b. Steel flanges and tube with epoxy finish.
    c. Buna-nitrile seals.
    d. Steel bolts, washers, and nuts.
    e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm.)

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

D. 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 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig (862 kPa).
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

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

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

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

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

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

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Bronze Plug Valves: MSS SP-78.

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

    a. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

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

    a. McDonald, A. Y. Mfg. Co.
    b. Mueller Co.; Gas Products Div.
    c. Xomox Corporation; a Crane company.

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig (862 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. PE Ball Valves: Comply with ASME B16.40.

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

   a. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig (552 kPa).
8. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

J. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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

a. Vanguard Valves, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig (34.5 kPa).
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

B. Earthquake Valves: Comply with ASCE 25.

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

a. Pacific Seismic Products, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 60 psig (414 kPa).
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem O-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 (DN 50) and smaller; flanged for valves NPS 2-1/2 (DN 65) and larger.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

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

a. Actaris.
b. American Meter Company.
c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
d. Invensys.
e. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig (690 kPa).

C. Line Pressure Regulators: Comply with ANSI Z21.80.

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

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 5 psig (34.5 kPa).

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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

    a. Canadian Meter Company Inc.
    b. Eaton Corporation; Controls Div.
    c. Harper Wyman Co.
    d. Maxitrol Company.
    e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 5 psig (34.5 kPa).

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Hart Industries International, Inc.
    d. Jomar International Ltd.
    e. Matco-Norca, Inc.
    f. McDonald, A. Y. Mfg. Co.
    g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    h. Wilkins; a Zurn company.

2. Description:

    a. Standard: ASSE 1079.
    b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
    c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Matco-Norca, Inc.
    d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    e. Wilkins; a Zurn company.

2. Description:

    a. Standard: ASSE 1079.
    b. Factory-fabricated, bolted, companion-flange assembly.
    c. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
    d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.

2. Description:

    a. Nonconducting materials for field assembly of companion flanges.
    b. Pressure Rating: 150 psig (1035 kPa).
    c. Gasket: Neoprene or phenolic.
    d. Bolt Sleeves: Phenolic or polyethylene.
    e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.
4. Design, obtain EOR approval and install cathodic protection.

E. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

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

G. Install pressure gage downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

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

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

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

E. 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.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

3. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. 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.

3.8 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).

D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
4. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

3.9 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.11 PAINTING

A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (flat).
d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (flat).
d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (flat).
d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) 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 (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig (20.7-MPa), 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.14 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.15 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:

1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
2. Black steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating and cathodic protection for steel piping.

B. Aboveground natural-gas piping shall be one of the following:

1. Black steel pipe with malleable-iron fittings and threaded joints.
2. Black steel pipe with wrought-steel fittings and welded joints.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground, branch piping NPS 4 and smaller shall be one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Black steel pipe with malleable-iron fittings and threaded joints.
2. Black steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be one of the following:

1. Black steel pipe with malleable-iron fittings and threaded joints.
2. Black steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: Maximum operating pressure more than 5 psig (34.5 kPa).

B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.

C. Aboveground, distribution piping shall be one of the following:

1. Black steel pipe with steel welding fittings and welded joints.

D. Underground, below building, piping shall be one of the following:

1. Black steel pipe with malleable-iron fittings and threaded joints.
2. Black steel pipe with wrought-steel fittings and welded joints.

E. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

F. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

END OF SECTION 23 1123

SECTION 232113 - 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. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Makeup-water piping.
3. Condensate-drain piping.
4. Air-vent piping.
5. Safety-valve-inlet and -outlet piping.
6. Chemical treatment piping.

1.3 ACTION SUBMITTALS

A. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS

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

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

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

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

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

a. Anvil International.
b. Star Pipe Products.
c. Victaulic Company.

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, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. 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 "Piping Applications" Article.

C. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

D. 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.

E. Grooved Mechanical-Joint Fittings and Couplings:

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

a. Central Sprinkler Company.
b. S. P. Fittings.
c. Smith-Cooper International.
d. Victaulic Company.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, 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 EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

F. 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 otherwise 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/A5.8M, 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 D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Description:

      a. Standard: ASSE 1079.
      b. Pressure Rating: 125 psig minimum at 180 deg F.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Description:

      a. Standard: ASSE 1079.
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Pressure Rating: 125 psig minimum at 180 deg F.
      d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating 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.

E. Dielectric Nipples:
   1. Description:

      a. Standard: IAPMO PS 66.
      b. Electroplated steel nipple, complying with ASTM F 1545.
      c. Pressure Rating: 300 psig at 225 deg F.
      d. End Connections: Male threaded or grooved.
      e. Lining: Inert and noncorrosive, propylene.

2.5 BYPASS CHEMICAL FEEDER

A. Description: 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.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Water piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints (in shafts and inside the building).
2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints (on roof only).

C. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Air-Vent Piping:

1. Inlet: Same as service piping.
2. Outlet: Type M, annealed-temper copper tubing with soldered or flared joints.

F. 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.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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 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 unions in piping, NPS 2-1/2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 3 and larger, at final connections of equipment and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 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.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

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.
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.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

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 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 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 and Larger: 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.

3.5 PIPE 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 pipe and fittings before assembly.

C. 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.

D. 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/A5.8M.

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

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

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

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

H. 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.

3.6 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 butterfly valve around control valve.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

A. Install bypass chemical feeders in each hydronic system where indicated.

1. Install in upright position with top of funnel not more than 48 inches above the floor.
2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Install NPS 3/4 #316 stainless steel pipe and #316 all stainless steel ball valve from chemical pot feeder to the heating hot water mains. Provide dissimilar metal unions as required.
4. Install NPS 3/4 #316 stainless steel pipe drain to nearest approved drain receptor and include a full-size, full-port, #316 all stainless steel ball valve.

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.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace 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 the "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 232113

SECTION 232116 - HYDRONIC 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. Section includes special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Makeup-water piping.
3. Condensate-drain piping.
4. Air-vent piping.
5. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

A. Provide roof mounted equipment and piping supports and attachment details and calculations stamped and signed by registered in California structural engineer.

B. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. 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 1.

PART 2 - PRODUCTS

2.1 VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

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

a. Armstrong Pumps, Inc.
b. Bell & Gossett; a Xylem brand.
c. Flow Design, Inc.
d. Victaulic Company.

2. Body: Bronze, ball or plug type with calibrated orifice or Venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

B. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

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

a. AMTROL, Inc.
b. Bell & Gossett; a Xylem brand.
c. Spence Engineering Company, Inc.
d. Watts; a Watts Water Technologies company.

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.

2.2 AIR-CONTROL DEVICES

A. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Basis of Design Product: Furnish and install as shown on the drawings by Spirotherm Spirotop automatic air release valves on the hot and chilled water systems.
2. Body: Cast brass,
3. Rated for 150 psig design pressure, and 270F operating temperature
4. Internal Parts: Nonferrous floats, stainless steel linkage and Viton seal which closes against a brass spring operated seat.
5. Warranty: 20 year limited warranty against defects in materials and workmanship.
6. Inlet Connection: ½" FPT and ¾" MPT
7. Vent Connection: ½" NPT

B. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. Taco, Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

C. Combination Air Eliminator, Dirt Separator, Hydraulic Separator

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Basis of Design Product: Furnish and install as shown on the drawings and schedule a Spirotherm Quad VDX full flow coalescing type combination air eliminator, dirt separator, hydraulic separator for the hot water systems.

2. Separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include three performance chambers within the vessel. One chamber above the higher nozzle set for air elimination, one below the lower nozzle set for dirt separation, and one between the nozzles for hydraulic separation.
3. The vessel diameter, height above and below the nozzles, and distance between the nozzles must be equal to the basis of design.
4. Unit shall include internal Spirotube® elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location.
5. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes.
6. The elements must consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.
7. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
8. Alternates must be approved to bid 10 days prior to bid date and include dimensional drawing to verify actual size of vessel, verification of 150 psi ASME construction, and venting mechanism. A detailed certified drawing and photos of alternate coalescing elements shall be included showing material, grade, style, type, and placement of such elements within the vessel. Reduced vessel size, partial fill, or elements spaced apart will not be accepted. Alternates submitted for prior approval will not be subject to Revise and Resubmit option and will receive only one review. If not approved, basis of design must be furnished.

2.3 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: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

B. 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.

PART 3 - EXECUTION

3.1 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 furnished by the boiler manufacturer safety valves at hot-water generators. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at all 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 near the air handling unit cooling coil.

C. Install piping from boiler air outlet, air separator 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 expansion tanks on the roof. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

F. Provide housekeeping pads for all roof mounted equipment.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Close coupled, inline centrifugal pumps.
   2. Automatic condensate drain pump units.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

   1. Show pumps layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Basis of Design: Armstrong Design Envelope Sensorless 4380 Closed Coupled Type Vertical In-Line Centrifugal pumps.
2. The following manufacturers will be considered for deductive alternates pending full compliance with these specifications.
a. Crane Pumps & Systems.
b. Grundfos Pumps Corporation.
c. ITT Corporation; Bell & Gossett.
d. Mepco, LLC.
e. PACO Pumps.
f. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
g. Peerless Pump Company.
h. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump with integrated VFDs as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

C. The pump shall be radially split, single stage centrifugal type with bronze fitted casing with equal size suction and discharge flanges and having separate tapped flush line and pressure gauge connections,

D. Bronze (BS1400 Grade LG1) dynamically balanced impeller, 316SS shaft sleeve, inside type mechanical seal, with carbon rotating face, Sintered Silicon Carbide stationary seat, and EPDM secondary seal. The pump is to be fitted with a factory installed flush line.

E. The variable frequency drive & controls shall be rated UL Type 12 or UL Type 4X and be an integral component of the pumping unit with a TEFC, 460/3/60, motor efficiency NEMA Prem (12.12).
1. The integrated VFD shall be of the VVC-PWM type providing near unity displacement power factor (cos Ø) without the need for external power factor correction capacitors at all loads and speeds.
2. The VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents and to reduce the DC link ripple current thereby increasing the DC link

capacitors lifetime. RFI filters will be fitted as standard to ensure the VFD meets low emission and immunity requirements.

3. VFD and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, overvoltage, under-voltage, motor over-temperature, inverter overload, over-current.
4. The VFD shall have the following additional features:
   a. Sensorless override for BAS/BMS control signal
   b. Manual pump control or closed loop PID control
   c. Auto alarm reset
   d. Four programmable digital inputs, two analog inputs, one programmable analog / digital output
   e. One volt-free contact
   f. One RS485 port for serial communications to building management systems
   g. Standard serial communication protocols BACnet MS/TP (default), Modbus RTU, Johnson Controls Metasys N2, or Siemens FLN
   h. Environmental Ratings
      1) Temperature: 14°F to 113°F up to 3300 ft (-10°C to 45°C up to 1000 m)
      2) Max Relative Humidity: 0 to 95%

2.2 AUTOMATIC CONDENSATE PUMP UNITS

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

B. Basis-of-Design Product: Subject to compliance with requirements by one of the following:

1. Beckett Corporation.
2. Hartell Pumps Div.; Milton Roy Co.
3. Little Giant Pump Co.
4. Mepco, LLC.

C. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

2.3 PUMP SPECIALTY FITTINGS

A. Pump support
1. Hot dipped galvanized post.
2. Hot dipped galvanized mounting plate.
3. #316 ss anchor bolts (4 per plate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

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

3.2 PUMP INSTALLATION

A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

D. Equipment Mounting:

1. Install in-line centrifugal pumps on concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Provide mounting bracket. Submit installation details to the EOR for review and approval.

D. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

E. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

F. Install check, shutoff, and throttling valves on discharge side of pumps.

G. Install suction diffuser and shutoff valve on suction side of pumps.

H. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

I. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

J. Install check valve and ball valve on each condensate pump unit discharge.

K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT 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 refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

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

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 PIPING INSTALLATION

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

B. Install refrigerant piping according to ASHRAE 15.

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 above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels, if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

M. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

N. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

P. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 PIPE 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 pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
3. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.
b. System shall maintain test pressure at the manifold gage throughout duration of test.
c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

END OF SECTION 232300

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC 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 the following water treatment for closed-loop hydronic systems:

1. Chemical-feed equipment.
2. Chemicals.

B. Related Requirements:

1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water softeners, RO equipment, and filtration equipment.

1.3 DEFINITIONS

A. 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.

B. RO: Reverse osmosis.

C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer.

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

B. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
2. Water Analysis: Illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.

2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Ampion Corp.
2. Aqua-Chem, Inc.
3. Nalco; an Ecolab company.
4. Watcon, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hot-water heating systems, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TSS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL
    c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.

d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 5 gal.
2. Minimum Working Pressure: 125 psig.

2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water testing equipment on wall near water chemical application equipment.

D. Install interconnecting control wiring for chemical treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in hot-water heating system including the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install turbine water meter in makeup-water supply.
3. Install full-port ball isolation #316 ss valves on inlet, outlet, and drain below the feeder inlet.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."

C. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

D. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested, and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.

E. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 232513

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "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 and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

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

1.4 ACTION 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, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: 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.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

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

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

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

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

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

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

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

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

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.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "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."

2.3 SHEET METAL MATERIALS

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

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

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

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

D. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied 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 when tested according to UL 723; certified by an NRTL.
5. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

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

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

F. 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.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

    a. CertainTeed Corporation.
    b. Johns Manville; a Berkshire Hathaway company.
    c. Knauf Insulation.
    d. Owens Corning.
        1) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

    a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of

Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-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 stainless 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 7-11, "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.

2.5 SEALANT AND GASKETS

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

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

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

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

5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-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.

2.6 HANGERS AND SUPPORTS

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

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

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

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

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

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

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

H. Trapeze and Riser Supports:

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

2.7 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

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

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

C. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

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 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 Section 233300 "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 "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

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

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

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

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

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

3.3 DUCT SEALING

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

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

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
4. Unconditioned Space, Exhaust Ducts: Seal Class C.
5. Unconditioned Space, Return-Air Ducts: Seal Class B.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
8. Conditioned Space, Exhaust Ducts: Seal Class B.
9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

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

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

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

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

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

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

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." ASCE/SEI 7.

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

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

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

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

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

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

3.7 PAINTING

A. Paint interior of metal ducts that are visible through 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 Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

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

    a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
    c. Return Ducts: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
    d. Exhaust Ducts: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.

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

C. Duct System Cleanliness Tests:

1. Keep all systems open ends capped at all times when no installation is conducted. Dust accumulation inside the installed ductwork or in unassembled duct fittings will not be permitted and it will trigger cleaning of the entire system. 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.

3.9 DUCT CLEANING

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

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

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

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

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft dampers.
2. Manual volume dampers.
3. Control dampers.
4. Smoke dampers.
5. Combination fire/smoke dampers.
6. Flange connectors.
7. Duct silencers.
8. Turning vanes.
9. Remote damper operators.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

B. Related Requirements:
1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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. Combination fire/smoke-damper, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

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

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

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 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.

2.2 MATERIALS

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

1. Galvanized Coating Designation: G90.

2. Exposed-Surface Finish: Mill phosphatized.

B. 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.

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

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

2.3 BACKDRAFT DAMPERS

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

1. Nailor Industries Inc.
2. Pottorff.
3. Ruskin Company.
4. Vent Products Co., Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.063-inch- thick extruded aluminum, with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch-width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:

1. Material: Nonferrous metal.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball.

M. 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.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

    a. Flexmaster U.S.A., Inc.
    b. McGill AirFlow LLC.
    c. Nailor Industries Inc.
    d. Pottorff.
    e. Ruskin Company.
    f. Vent Products Co., Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
    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. Opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Oil-impregnated bronze.

b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

2.5 COMBINATION FIRE/SMOKE DAMPERS

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

1. Nailor Industries Inc.
2. Pottorff.
3. Ruskin Company.

B. Type: 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 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours or as indicated on the architectural code plan.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded interlocking, gusseted or mechanically attached corners and mounting flange.

F. Heat-Responsive Device: Resettable, 165 deg F rated, fire-closure device.

G. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.

H. Smoke Detector: Integral, factory wired for single-point connection for installation within 5 ft from FSD it serves. Omit smoke detector if the building has full coverage fire alarm system.

I. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.

J. Leakage: Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, 0.05-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

M. Master control panel for use in dynamic smoke-management systems.

N. Damper Motors: two-position action.

O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "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 Section 230923 "Direct Digital Control (DDC) System 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: 115 V, single phase, 60 Hz.

P. Accessories:

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, remote mounted.

2.6 SMOKE DAMPERS

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

1. Nailor Industries Inc.
2. Pottorff.
3. Ruskin Company.

B. Type: 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 2000-fpm velocity.

D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded interlocking, gusseted or mechanically attached corners and mounting flange.

E. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.05-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "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 Section 230923 "Direct Digital Control (DDC) System 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. Electrical Connection: 115 V, single phase, 60 Hz.

K. Accessories:

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, remote mounted.

2.7 FLANGE CONNECTORS

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Hardcast, Inc.
4. Nexus PDQ.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.8 DUCT SILENCERS

A. 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.

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/A 653M, G90, galvanized sheet steel, thick.

E. Inner Casing and Baffles: ASTM A 653/A 653M, 304 SS for the supply air duct and G90 galvanized sheet metal, 0.034-inch- thick, and with 1/8-inch-diameter perforations for the return air duct.

F. Connection Sizes: Match connecting ductwork unless otherwise indicated.

G. 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 15 percent compression.
b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: None.
4. Insulation: See Specification section 230713 - DUCT INSULATION.

H. 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. Joints: Lock formed and sealed or flanged connections.
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.

2.9 TURNING VANES

A. 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.

B. 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.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single or Double wall as applicable.

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.10 REMOTE DAMPER OPERATORS

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

1. Pottorff.
2. Ventfabrics, Inc.
3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Aluminum.

D. Cable: Steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.11 DUCT-MOUNTED ACCESS DOORS

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

1. Ductmate Industries, Inc.
2. Flexmaster U.S.A., Inc.
3. McGill AirFlow LLC.
4. Nailor Industries Inc.
5. Pottorff.
6. Ventfabrics, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. 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: Continuous and two sash locks.
c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.12 DUCT ACCESS PANEL ASSEMBLIES

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

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

B. Labeled according to UL 1978 by an NRTL.

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

D. Fasteners: 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.

2.13 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Hardcast, Inc.
3. Ventfabrics, Inc.
4. Ward Industries; a brand of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

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

D. 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.

2.14 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. Flex-Tek Group.
3. McGill AirFlow LLC.
4. Ward Industries; a brand of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene 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.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.15 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 smoke dampers in the main supply and return ducts at the roof mounted air handling unit for the unit separation from the air distribution system in case of emergency.

E. 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.

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

G. Install test holes at fan inlets and outlets and elsewhere as indicated.

H. Install fire/smoke dampers according to UL listing.

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. At outdoor-air intakes and mixed-air plenums.

2. At drain pans and seals.
3. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
4. 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.
5. At each change in direction and at maximum 50-foot spacing.
6. Upstream from turning vanes.
7. Upstream or downstream from duct silencers.
8. Control devices requiring inspection.
9. 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 Section 230553 "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 directly. Do not use flexible ducts to change directions.

Q. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

R. Connect flexible ducts to metal ducts with draw bands.

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, 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 233300

SECTION 233346 - FLEXIBLE 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. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For flexible ducts.

   1. Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

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 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.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. JP Lamborn Co.
3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene 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/IES 90.1.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

B. Non-Clamp Connectors: Adhesive.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts 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 in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts directly. Do not use flexible ducts.

D. Connect diffusers boots to ducts with maximum 72 lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with adhesive.

F. Install duct test holes where required for testing and balancing purposes.

G. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.

H. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3. Ducts may not rest on ceiling joists. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.

END OF SECTION 233346

SECTION 233600 - 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. Single-duct air terminal units with terminal reheat.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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.

2.2 SINGLE-DUCT AIR TERMINAL UNITS

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

1. Anemostat Products; a Mestek company.
2. Carnes Company.
3. ENVIRO-TEC; by Johnson Controls, Inc.
4. Krueger.
5. Nailor Industries Inc.
6. Titus.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 22 GA thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.

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 access panels upstream and downstream of the coil for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Access panel.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 3 percent of nominal airflow at 6-inch wg inlet static pressure.
2. Damper Position: Normally open.

F. Attenuator Section: 0.034-inch steel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

G. Hydronic Heating 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.

H. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) 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 Section 230923 "Direct Digital Control (DDC) System for HVAC."

I. Controls:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

2. System-powered, wall-mounted thermostat.
3. 120V/24V unit mounted transformer and toggle switch.

2.3 CASING LINER

A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Minimum Thickness: 1 inch.

a. Maximum Thermal Conductivity:
1) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. Adhesive VOC Content: 80 g/L or less.
b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. 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.

3.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." Comply with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

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

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

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

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect 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. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.

5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.3 TERMINAL UNIT 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 air terminal units within 12 inches above ceiling for easy maintenance access.

3.4 CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and 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. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.5 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following 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.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. 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.

3.8 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 233600

SECTION 233713 - 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. Modular core supply air diffusers.
   2. Fixed face return and exhaust air registers and grilles.

B. Related Sections:
   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION 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.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Modular Core Diffusers:

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

    a. Anemostat Products; a Mestek company.
    b. Carnes Company.
    c. Krueger.
    d. METALAIRE, Inc.
    e. Nailor Industries Inc.
    f. Titus.
    g. Tuttle & Bailey.
2. Material: Steel.
3. Finish: White baked acrylic.
4. Border: 1-1/2-inch-width with countersunk screw holes.
5. Blades:
    a. Set in modules.

6. Modules: Removable; rotatable.
7. Mounting: Surface.

2.2 REGISTERS AND GRILLES

A. Fixed Face Grille:

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

    a. Anemostat Products; a Mestek company.
    b. Carnes Company.
    c. Krueger.
    d. Nailor Industries Inc.
    e. Titus.
    f. Tuttle & Bailey.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Core Construction: Integral.
5. Frame: 1 inch wide.
6. Mounting: Countersunk screw or Concealed.

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.

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 233713

SECTION 235233 - WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, copper finned water-tube boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

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

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
b. Attachments Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

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

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

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

2. Dimensioned Outline Drawings of 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.

B. Source quality-control test reports.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

B. Provide one additional set of final filters (one 99% efficient filter per boiler specified)

1.6 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. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil-Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. I=B=R Compliance: Boilers shall be tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.

F. UL Compliance: Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

G. The boiler shall bear the ASME “H” stamp and be National Board Listed for 160 psi working pressure and 250 deg F.

H. Provide services of manufacturer's authorized and factory-trained representative to perform the following functions:
   1. Inspect and verify installation
   2. Checkout and start-up/supervision. Submit startup report.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Company specializing in performing work of this section.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Accept equipment from damage and accessories on site in factory shipping packaging. Inspect for damage.

B. Protect equipment from damage by leaving packing in place until installation.

C. Equipment must be protected from inclement weather, flooding, electrical surges, etc.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard of boilers that fail in materials or workmanship within specified warranty period.

   1. Warranty Period for Heat Exchangers: 5-year limited warranty and 20-year warranty against thermal shock, from date of start-up not to exceed eighteen (18) months from shipment.

   2. Warranty Period for Burners: 10 years from date of start-up not to exceed eighteen (18) months from shipment.

   3. Warranty Period for all over parts: 1-year from date of start-up not to exceed eighteen (18) months from shipment.

1.11 START-UP OF EQUIPMENT

A. Operating and Maintenance instructions are to be furnished with each unit.

B. The boiler shall be factory assembled and fire tested requiring only connections to the water circulating system (supply & return), fuel, electrical power, exhaust vent and air inlet (as specified/shown in contract drawings.)

C. Factory-authorized representatives shall perform start-up service on each unit.

PART 2 - PRODUCTS

2.1 VERTICAL COPPER FINNED WATER-TUBE NON-CONDENSING BOILERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide Thermal Solutions outdoor rated EVOM or a comparable product by one of the following:

D. Deductive Alternates:
1. The following manufacturers will be considered for deductive alternates pending full compliance with these specifications.
   - Lochinvar Corporation.
   - Patterson-Kelley.

2. Manufacturers must submit a request to bid in writing to the owner, or owner's consultant two weeks prior to bid date. Failure to do so will be grounds for bid rejection. Alternate bids must be entered with savings over base bid. The manufacturer must provide the following information for consideration prior to entering a bid:
   - List of deviations to the specification
   - Equipment selection data

E. Description: The boiler shall be a factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted and wired, as specified in this Section. The boiler shall be factory assembled and fire tested. Boiler connections shall be limited to the water supply & return, relief valve and boiler trains, fuel, electrical power, and exhaust bent and air inlet (as specified/shown in contract documents).

F. Heat Exchanger:
1. Straight copper tubing with extruded, integral copper fins.
2. Fin spacing: at least (7) fins per inch
3. Tube Thickness: 0.072"
4. Cast Iron headers.
5. Two-pass vertical configuration.

6. Tubes shall be sealed in header by mechanically rolling tubes securely in header (top and bottom). There shall be no bolts, gaskets, "O-Rings", welding or brazing used in the header construction.
7. Heat exchangers shall be constructed in accordance with Section IV of the ASME code.
8. The heat exchanger design must allow for individual access and replacement of each tube. Removable access plugs shall be included to allow for access, cleaning, and inspection, and replacement of each individual tube.
9. The heat exchanger shall encompass the entire burner and be enclosed in stainless steel with a fully water-balked tube sheet.
10. The heat exchanger shall be of sufficient size and design to ensure effective, non-limiting control of the water flow rate and velocity through each tube at all load levels.
11. The heating surface of the heat exchanger shall be no less than 6.5 square feet per boiler horsepower.

G. Casing:

1. Jacket: Minimum 16-gauge negative pressure aluminized steel jacket
2. Control Compartment Enclosure: NEMA 250, Type 1A.
3. Finish: UV resistant powder coated
4. Boiler control panel shall be non-pressurized allowing boiler operation with any jacket panel removed during inspection or maintenance periods.
5. The jacket panels must be lockable to prevent unwanted tampering of the controls.
6. Hinge-less front and rear access panels shall be provided for easy access to the operating controls and to eliminate electric code "swing radius" clearance issues.

H. Burner:

1. Fuel Burning System
   a. Radiant non-corroding ceramic burner, with no moving parts. Double-meshed screen, fiber-metal mats, aluminized or stainless steel construction of the burner will not be accepted.
   b. The burner shall fire in a full 360-degree pattern providing uniform heat transfer across the entire heat exchanger. A viewing port shall be provided for visual observation of burner performance. Burner shall require no maintenance, inspection, or service.
   c. Burner operation shall be Full Modulation with minimum 3:1 turn down utilizing a VFD and air-fuel ratio valve for dependable, repeatable modulation and precise combustion control. Dampers, linkages or a one-speed fan are not acceptable.
   d. Interrupted-type mixed fuel/air pilot system with electric spark-to-pilot ignition that utilizes a UV scanner to prove pilot before main gas valves open. Hot surface ignition systems and flame rods are not acceptable.
   e. The entire firing control sequence shall be monitored by a UL approved, commercial-type microprocessor flame safeguard programmer with first out fault annunciation and diagnostic indicator lights. Furnish pre-purge and post-purge timing. Shut down burner in the event of ignition pilot and/or main flame failure with manual reset.
   f. Full frontal access port shall be provided for the control area.

g. The boiler will be equipped with a non-sparking blower manufactured with a cast aluminum housing.
h. Combustion air pressure switch shall be provided.
i. The blower shall be equipped with a replaceable combustion air filter, 99% efficient to one micron to protect the burner from contamination. A Delta-P style pressure switch shall be provided to alert the boiler operator of a dirty filter condition. Air inlet dampers and vacuum relief dampers are not required for proper operation. A combustion air flow switch shall be provided.
j. The burner shall emit no more than 9ppm NOx and 50 ppm CO (corrected to 3% O2) at all firing rates
k. The sound level for a single boiler shall be no more than 50 Db.

B. Gas Train

1. Gas train shall be UL/FM/CSD-1 compliant.
2. The gas train shall be certified to take a maximum of 5 psi Natural Gas. Additional step-down regulators are not allowed and can cause nuisance shutdowns of the unit.
3. Pilot and main gas pressure regulator.
4. Automatic main and redundant gas valves.
5. Leak test valves downstream of each gas valve.
6. High and low gas pressure switches with manual reset.
7. Manual shut off valve upstream of burner and downstream of last gas valve.
8. The main gas valve shall perform the functions of safety shutoff, constant pressure regulation and air-fuel ration control.

I. Trim:

1. ASME rated pressure relief valve set at 125 psig.
2. Combination water pressure and temperature gage. Furnish graduated pressure gauge scale from 1-1/2 to 3 times of pressure relief valve setting.
3. A water flow switch to prevent burner operation during low water flow conditions.
4. Adjustable high limit temperature controller with manual reset to prevent water temperature from exceeding a safe system temperature
5. Auxiliary Low Water Cutoff to provide redundant low water protection

J. Air Intake Piping

1. When used for sealed combustion, air intake piping can be PVC or galvanized smoke pipe that is sealed and pressure tight. Pipe must be at least the same size as the air inlet connection on the boiler
2. Intake dampers and vacuum relief dampers are not required for sealed combustion/direct venting. Vacuum relief dampers can violate the intent of sealed combustion/direct vent applications.

K. Controls:

1. The boiler shall be equipped with a microprocessor-based Temperature Controller to control burner firing rate modulation in response to boiler heat load

2. A temperature sensor shall be located in the outlet side of the heat exchanger to provide the input signal to the Temperature Controller.

3. The output signal from the Temperature Controller shall vary the blower speed via the Variable Frequency Drive.

4. The Temperature Controller shall have a user-friendly menu that allows easy selection of desired operating temperature, upper and lower temperature set-point limits, burner on/off thresholds, PID control loop characteristics, and local or remote operating temperature.

5. The Temperature Controller shall be capable of accepting either a 0-10 vdc of 4-20mA remove signal for changing temperature set-points and/or remote modulation control. The control system shall be capable of communication with a BAS/BMS using Modbus communication protocol.

6. Cold start control valve, piping and controls shall be factory furnished with each boiler.

2.2 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to fuse disconnect switch.
5. Provide branch power circuit to each motor and to controls.
6. Provide each motor with overcurrent protection.

2.3 VENTING KITS

A. Kit: The boiler shall be designed to accommodate sealed, direct, or conventional venting options. The flue duct shall be AL 29-4C, positive pressure type vent material.

B. Barometric dampers are not allowed unless multiple boilers are combined into the same common vent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine roof spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Install boilers level on concrete housekeeping pad. Concrete materials and installation requirements are specified with concrete. Provide 1/8" thick neoprene pad under the boiler. Attach boiler to pad in accordance with the boiler manufacturer's recommendations.

B. In accordance with Contract Documents and boiler manufacturer's printed instructions.

C. Flush and clean boilers upon completion of installation in accordance with manufacturer's start-up instructions. The boiler must be isolated when any cleaning or testing of system piping is being performed.

D. Install skid plumb and level, to plus or minus 1/16 inch over base.

E. Maintain manufacturer's recommended clearances around and over equipment, and as required by local Code.

F. Arrange all electrical conduit, piping, exhaust vent, and air intake with clearances for burner removal and service of all equipment.

G. Connect full size exhaust vent to boiler vent connection.

H. If shown in Contract Drawings, connect full sized air inlet vent to flanged connector on boiler.

I. Connect fuel piping in accordance with NFPA 54. Pipe size to be the same, or greater, than the gas train inlet connection.

J. Use full size (minimum) pipe/tubing on all gas vent connections.

K. Connect water piping, full size, to water supply and return connections.

L. Install all piping accessories per the details on the Contract Documents.

M. Install discharge piping from relief valves (open termination for viewing) and all drains to nearest floor drain.

N. Provide necessary water treatment to satisfy manufacturer's specified water quality limits.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

D. Connect hot-water piping to supply- and return-boiler tapping with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valves to nearest floor drain.

F. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

G. Boiler Flue Venting:

1. Install venting kit and combustion-air intake.
2. Connect full size to boiler connections.

H. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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 installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, 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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235233

SECTION 237313 – CUSTOM AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Custom variable volume air handling units.

1.2 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Provide calculations and details for the air-handling unit attachment to roof stamped and signed by a registered in California structural engineer.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. All major components used to assemble air handling unit, with the exception of electrical devices, control dampers, drives, bearings, and controls, shall be manufactured by the same air handling unit manufacturer. Primary fans and coils not manufactured by the same air handling unit manufacturer is not considered single source responsibility and shall not be acceptable.

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 Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

D. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

G. Comply with NFPA 70.

1.4 WARRANTY

A. Manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Energy Labs
2. Scott Springfield
3. Haakon

2.2 UNIT CONSTRUCTION

A. Unit Base

1. Each unit shall be constructed on a base fabricated from ASTM A36 welded structural steel channel. Tubular or formed metal channel bases are not acceptable. Channel bases shall be sized as a function of air handling length as follows:

A.H. UNIT LENGTH	MINIMUM CHANNEL SIZE	
UP to 10	4” x 1-5/8”	(5.4lbs/Lin.Ft.)
11’ to 20’	6” x 2”	(8.2lbs/Lin.Ft.)
21’ to 30’	8” x 2-1/2”	(11.5lbs/Lin.Ft.)
31’ to 40’	10” x 2 3/5”	(15.3 lbs/Lin.Ft.)
41’ to 50’	12” x 3”	(20.7lbs/Lin.Ft.)

B. Unit Cabinet

1. Housing: The unit housing side and roof panels shall be constructed of 16-gauge galvanized steel and shall utilize a standing seam modular panel type construction.

All floors shall be constructed of 14-gauge galvanized steel. The panels shall be caulked and attached to each other, to the roof, and to the floor using nuts and bolts on no less than 8" on center. Drive screw attachment is not acceptable. All panels shall be removable. All seams shall be sealed with an acrylic latex sealant prior to assembling the panels and after completion of the assembly. All floor openings shall have 12-gauge galvanized steel-framed flange around the entire perimeter of opening for duct connection. Minimum sound transmission loss (STL) through unit panels shall be as follows:

OCTAVE BAND CENTER FREQUENCY

125	250	500	1K	2K	4K
25	29	36	42	47	48

2. Insulation and Interior Liner: Insulation shall be 2" thick, 3 lbs per cubic foot density, neoprene coated fiberglass to cover all walls and ceilings. This insulation shall meet NFPA-90A smoke and flame spread requirements. All floors shall be insulated from below using minimum 2" thick foam to insure that the entire under surface of the floor is insulated. There shall be no raw edges of insulation exposed to the air stream. The entire interior of all units shall be lined with minimum 20 gauge bright galvanized steel liner. The interior liner of the fan sections, inlet plenum sections, and discharge plenum sections shall be perforated and the remaining shall be steel.
3. Drain Pans: Drain pans shall be constructed from 16-gauge, 316 stainless steel. Galvanized steel drain pans are not acceptable. The drain pan shall be insulated with minimum 2.0" thick foam insulation to prevent condensation under the drain pan. Drain pans must be sized such that the entire coil, including headers and return bends, are inside the drain pan. Drain pans must slope in two directions so there is no standing water in drain pan. Stainless steel condensate connection shall be provided on one side of the unit. Coils shall be supported on 10-gauge stainless steel members to prevent immersion of the coil in condensate and allow for complete cleaning of drain pan beneath the coils.

C. Access Doors
1. All access doors shall be of thermal break construction, hinged, double wall, insulated, man size access doors shall be provided in all sections requiring access for maintenance or service. The frame shall be constructed of extruded aluminum, fully welded at the corners with an anodized finish. The doors shall utilize a dual gasket seal system. All hardware provided shall be non-corrosive and all hinges and latches shall be adjustable with nuts and bolts. Access door must not leak more than 25 CFM @ 6" static pressure.
2. Door hinges and latches shall be easily adjustable, without the use of shims or special tools, to allow for a tight seal between the door and the doorframe as the gasketing material compresses over time. The door hinge design shall allow for field reversing of door swing and doors shall be easily removable. Provide door detail drawing with submittal package.
3. Doors entering into any section of the air handler that contains rotating fans or UV lights shall be provided with a door interlock safety switch to de-energize the fan

motor or UV lights upon opening. Each fan section and UV light section shall include a 8" x 12" wire reinforced UV protected glass view window in an access door.

D. Paint Finish
1. After final assembly the unit exterior shall be coated with an industrial grade self-priming semi-gloss high solids 2K polyurethane gray 219GY1 finish. In addition, all fan bases, springs, and structural steel supports shall be coated with the same finish. The paint system shall meet ASTM B117 2000 hour salt spray test.

2.3 INTERNAL COMPONENTS

A. Fan Assembly
1. Supply and return fans shall be direct drive Arrangement #4 plenum fans. Fan wheel shall be aluminum with aluminum extruded airfoil blades. The fan inlet shall be isolated from the cabinet by means of a neoprene-coated flexible connection. Plenum fans shall be provided with spring-style thrust restraints.
2. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. Fans shall be tested in accordance with AMCA 210 and AMCA 301 test codes for air moving devices and shall be guaranteed by the manufacturer to deliver rated published performance levels. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air. Fans shall have a sharply rising pressure characteristic extending through the operating range and continuing to rise beyond the efficiency peak to ensure quiet and stable operation. Fans shall have a non-overloading design with self-limiting horsepower characteristics and shall reach a peak in the normal selection area. All fans shall be capable of operating over the minimum pressure class limits, as specified in AMCA Standard 2408-69.
3. Fan Base, Spring Isolation, and Support Framing: Mount fan and motor on an internal, fully welded, rigid steel base. Base shall be free-floating at all four corners on spring type isolators with earthquake restraints. The fan assembly shall be isolated from the cabinet by steel springs with minimum deflection of 2.0" or as indicated on schedules. The spring isolators shall be mounted to structural steel members. All isolators shall be rated for zone 4 seismic requirements. The spring isolators shall be mounted on a waffle pad for vibration isolation.
4. Balancing: All fans prior to shipment shall be completely assembled and test run as a unit at the specified operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings. Records shall be maintained, and a written copy shall be available upon request.

B. Motors
1. Furnish premium-efficiency invertor duty TEFC, NEMA frame, ball bearing type motors. The Horsepower values as shown on the schedule are minimum allowable.

2. The fan motors shall be factory wired to an external VFD with flexible conduit of adequate length so that it will not have any effect on the vibration isolation.

C. Fan Airflow Measurement:
1. Manufacturer shall be Ebtron, Fan Inlet Hybrid Series or approved equal.
2. Each fan shall have a sensor face mounted at the inlet cone without affecting fan performance or sound. Each sensor node shall be shall contain two individually wired, hermetically sealed bead-in-glass thermistors. Airflow accuracy shall be ± 2% of reading over the entire operating airflow range of not less than 0 to 5,000 fpm.
3. A single transmitter shall be provided for each bank of fans with an integral, minimum 16-character LCD display capable of simultaneously displaying total airflow and temperature. The LCD display shall also be capable of displaying individual fan airflow and temperature readings of each independent sensor node.
4. Output signal 4-20 mA. DC or 0-5 VDC standard.
5. The transmitter shall be housed in a NEMA 1 enclosure with external signal tubing, power and output signal connections.

D. Coils
1. Chilled water coils shall be of the plate fin extended surface type. Tubes shall be 5/8" outside diameter seamless copper with a 0.020" minimum wall thickness. Each coil shall have individually replaceable return bends of 0.025 wall thickness on both sides of the coil. Coils incorporating a "hairpin" type design are not acceptable. Tubes shall be expanded into the fin collars to provide a permanent mechanical bond.
2. The secondary surface shall be formed of 0.008" aluminum fins and shall be spaced not closer than 12 fins per inch with integral spacing collars that cover the tube surface. Headers shall be non-ferrous seamless copper, outside the air stream and provided with brazed copper male pipe connections. Drain and vent tubes shall be extended to the exterior of the air handling unit.
3. All coils shall have counter flow construction with connections left or right hand as shown on the drawings. The use of internal restrictive devices to obtain turbulent flow will not be accepted.
4. Cooling coil casings shall be of minimum 16-gauge, 316 stainless steel with double-formed 1-1/4" stacking flanges and 3/4" flanges on the side plates. All other coil casing shall be of 16-gauge galvanized steel. Flanged tube sheets shall have extruded tube holes to prevent raw edges of tube sheets cut into copper tubes because of thermal expansion of tubes in tube holes. Tube holes with raw sheet metal edges are not acceptable. Reinforcing shall be furnished so that the unsupported length is not over 60". All coil assemblies shall be tested under water at 300 psi and rated for 150-psi working pressure. Headers are to be located inside the cabinet casing with only the pipe connections extending through the casing. All sides of coils shall be carefully blanked off with the same materials used for the coil casings, to ensure all air passes through the coil.
5. Intermediate condensate pans are to be furnished on multiple coil units and single coils greater than 48" high. The pans shall be 16Ga. 304 stainless steel and drain to the main drain pan through copper downspouts.

6. All water coils shall be rated in accordance with ARI Standard 410. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all coils supplied for the air handlers.

E. Filters
1. Filter sections shall be fabricated as part of the air-handling unit. Filters shall be arranged for upstream loading as shown on the drawings. Provide filter-holding frames to accommodate scheduled filters. Filter frames shall be 16 Ga. Hot dipped galvanized steel and shall be fully welded to reduce leakage of air through corners.
2. Factory install at each filter bank a Dwyer Magnehelic "Series 2000 ASF" pressure gauge complete with signal flags, static pressure tips, hardware and fittings. Enclose the gauge in a protective sheet metal box with a hinged inspection door. Paint to match unit.
3. Filter shall be mini-pleat high-efficiency, extended media area, totally rigid and disposable type. Air filters shall be MERV 13 and shall have average efficiency of not less than 85% when tested in accordance with ASHRAE 52-76 test standard. Filter pressure drop shall not exceed 0.30" at 500 FPM when clean. Filter shall be of the quantities and sizes as indicated on the drawings

F. Economizer Section
1. Economizer section shall include dampers for return air, fresh air and exhaust air. Dampers shall be opposed blade type. Dampers shall be sized for not greater than 1200 fpm face velocity based upon gross damper area. Dampers shall meet above specifications. Furnish full height 24" wide access doors for damper and linkage service.
2. Dampers shall be supplied with low leak extruded aluminum airfoil blades. Blades shall be supplied with rubber edge seals and stainless-steel arc end seals. Rubber edge seals shall be backed by the damper blade to assure a positive seal in the closed position. Dampers shall be provided with nylon bearings within extruded openings. Damper leakage shall not exceed 6 CFM/ft2 at 5.0" of static pressure. Leakage testing shall be in accordance with AMCA standard 500 figure 5.5. Test results must be from independent testing laboratory.

G. Outside Air Monitoring System
1. EBTRON, Inc. Model GTC116-PC is basis of design. (ATMD)
   a. All other vendors shall be considered as substitutions only. Substitutions for the basis of design requesting acceptance less than 30 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.
   b. Any product submitted as an equal shall be expected to comply with all performance, capabilities and functional aspects of this specification.
2. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, 32-bit microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor nodes contained in one or more probe assemblies per measurement location.
3. Probes shall be constructed of extruded, gold anodized, 6063 aluminum tubes. All internal wires within the tube shall be Kynar coated. PVC insulated conductors are not acceptable.

4. Each sensor node shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
5. Thermistors shall be mounted in the sensor node using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment. Thermistors leads shall not be fastened to the thermistor semiconductor substrate by weld or solder connections. Manufacturer shall provide UL listed, FEP jacketed, plenum rated cable(s) between sensor probes and the remote transmitter.
6. The airflow rate at each sensor node shall be equally weighted and arithmetically averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.
7. Each sensing node shall be individually wind tunnel calibrated at 16 points to NIST traceable airflow standards. Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range of not less than 0 to 5,000 fpm (25.4 m/s).
8. The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. Individual airflow and temperature readings of each independent sensor node shall be accessible. The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
9. The ATMD shall be UL 973 and BTL listed
10. The transmitter shall have two isolated and fused analog output signals and one RS-485 network connection. One analog output shall be for velocity and the other for a temperature output or LEED alarm function. All transmitters shall have integral self-diagnostics
11. Other than the thermistor sensors, no other electronic components shall be located at the sensing node. Signal processing circuitry on or in the sensor probe shall not acceptable.
12. Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable.
13. Devices with RJ-45 connections exposed to the environment or having electronic circuitry mounted in or at the sensor node are not acceptable.
14. Pitot tubes and arrays are not acceptable.
15. Vortex shedding devices are not acceptable.

H. Electrical Requirements
1. All AHU and electrical panel wiring shall be performed in a UL 508 listed shop. Provide single source power panels (SSPP's) that are constructed according to NEC regulations and carry a U.L.508 listing and label and installed in a NEMA3R enclosure. The panel shall include a non-fused main disconnect switch covering all fans in each unit, Motor Starters for constant volume units or VFD's for variable volume units, and any necessary transformers, Hand–Off–Auto switches, relays and pilot lights for complete operation of the fans in the unit. The single source power panels shall be factory wired to all factory furnished devices such as motors and interlocks.
2. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all electrical panel assemblies supplied for the air handlers. The air handling unit manufacturer shall be a U.L. 508 listed panel shop.
3. The main control panel shall have access door(s) for direct access to the controls. The panel shall contain a single externally operated, non-fused disconnect, suitable

for copper wire up to and including 3" conduit. The electrical contractor shall bring separate 460/3/60 power to the single source power panel.

4. All wiring shall be run in EMT conduit, (or flexible when connecting to a motor), raceways are not acceptable.
5. Provide fluorescent, marine style lights in each access section wired to a common weatherproof switch with 60-minute timer mounted adjacent to the supply fan access door. 120V GFI duplex service receptacles shall be installed and wired with the lighting circuit and located in each fan compartment.
6. If the unit requires splits, junction boxes shall be furnished on each section to allow the electrical contractor to make final connections in the field. Wiring shall be clearly labeled to allow ease in final interconnections.

I. Variable Frequency Drives

1. Furnish complete individual variable frequency VFDs with manual bypass for each fan designated on the drawing schedules to be variable speed to be installed inside the unit's vestibule. Comply with requirements in Division 23 Section "Variable Frequency Drives."

2.4 SOURCE QUALITY CONTROL

A. All major components used to assemble air handling unit, with the exception of electrical devices, control dampers, drives, bearings, and controls, shall be manufactured by the same air handling unit manufacturer. Primary fans and coils not manufactured by the same air handling unit manufacturer is not considered single source responsibility and shall not be acceptable.

B. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

C. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

D. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting: Install air-handling unit using internal vibration isolation.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance and to facilitate coils removal.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Install piping adjacent to air-handling unit to allow service and maintenance.

F. Connect condensate drain pans using size shown on the drawings, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

G. Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

END OF SECTION 237313

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Provide mounting details and calculations stamped and signed by structural engineer registered in the State of California.
3. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.

1.7 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:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

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

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. LG
   2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
   3. Panasonic
   4. SANYO North America Corporation; SANYO Fisher Company.

2.2 INDOOR UNITS

A. Concealed Evaporator-Fan Components:

   1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   2. Insulation: Faced, glass-fiber duct liner.
   3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
   4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
   5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
   6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
   7. Fan Motors:

      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
      c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

   8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   9. Filters: Permanent, cleanable.
   10. Condensate Drain Pans:

      a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 2 inches deep.

b. Stainless-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.
d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
f. Mount unit-mounted disconnect switches on exterior of unit.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:

a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 1 inch deep.

b. Stainless-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

8. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.
2) Thickness: 1 inch.
3) Merv according to ASHRAE 52.2: 8.
4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Charge: R-410A.
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 0 deg F.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Drain Hose: For condensate.

G. Additional Monitoring:

1. Monitor motor loads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units' level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated or stainless-steel fasteners.

D. Equipment Mounting:

1. Install air cooled condensing units on concrete equipment pads. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 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. 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 motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

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. 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 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment. Contractor to perform this testing:
   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. To connecting raceways, cables, wireways, and cable trays, 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 Access Panels."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping."

PART 2 PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

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

B. 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. 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.
      e. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, or cable trays, 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. Avoid core-drilling when possible. Install sleeves during erection of slabs and walls. Provide imaging of concrete slab in order to locate reinforcement and route electrical conduits accordingly.

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 “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.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section “Firestopping."

3.5 QUALITY CONTROL

A. Contractor is responsible for testing and surveying as required for quality control purposes.

END OF SECTION

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SECTION 260519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:
   1. Division 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 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.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Southwire Company.
   2. American Insulated Wire Corp.; a Leviton Company.
   3. General Cable Corporation.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW and SO.

D. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC mineral-insulated, metal-sheathed cable, Type MI and Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. 3M; Electrical Products Division.
   2. O-Z/Gedney; EGS Electrical Group LLC.
   3. AFC Cable Systems, Inc.
   4. Hubbell Power Systems, Inc.
   5. 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/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. All conductors for secondary power and lighting distribution system shall be new with 600V insulation rating and shall be delivered to job site in unbroken packages.

B. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW, THHN-THWN, single conductors in raceway.

C. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway.

D. Exposed Branch Circuits, Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

G. Class 1 Control Circuits: Type THHN-THWN, in raceway #14 AWG minimum..

H. Class 2 Control Circuits: Type THHN-THWN, in raceway.

I. Horn/Bell and smoke detector power circuits: #14 AWG minimum.

J. Alarm initiating circuits: #16 AWG inimum.

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. All feeders and branch circuits shall be marked in switchboards, panelboards and pull boxes.

G. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 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 (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

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 conductors feeding the following critical equipment and services 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 Substantial Completion.
      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

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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.
   1. Underground distribution grounding.
   2. SUBMITTALS

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

C. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Grounding arrangements and connections for separately derived systems.
   4. Grounding for sensitive electronic equipment.
   5. Field quality-control test reports.

D. 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 test wells and 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.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association 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.

D. Contractor is responsible for testing and surveying as required for quality control purposes.

PART 2 PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. System grounding conductors shall be a minimum of No. 4/0 AWG unless otherwise indicated and shall be continuous without joints or splices.

C. Insulated Copper Conductors
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Conductor: No. 4 or No. 6 AWG, soft drawn copper stranded conductor.
   5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators and standoffs. Provide in all electrical and communication rooms. Provide supplemental grounding system for buildings with sensitive equipment (electron Microscope, etc) to achieve low levels of resistance as required.

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 weld, Copper-clad steel, sectional type; 3/4-inch by10 feet in diameter and shall be driven to a depth not less than 8'-0".

B. Cold Water Pipe The main cold water steel pipe shall be bonded within 5' of its entry point to the building with a size 4/0 conductor.

C. Ufer Ground: Provide a minimum of 100' of size 4/0 stranded bare copper conductor in the footing to provide a base conductor or UFER Ground for the electrical system. At each end bond out to a ground rod with an inspection or test point.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 24 inches (600 mm) below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) 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. Conductor Terminations and Connections
   3. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   4. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   5. Connections to Ground Rods at Test Wells: Bolted connectors.
   6. 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. 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.

C. Water Heater: Install a separate insulated equipment grounding conductor to each electric water heater. Bond conductor to heater units, piping, connected equipment, and components.

D. 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.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. 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.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
   1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 100 feet of bare copper conductor not smaller than No. 4 /0 AWG.
   1. If concrete foundation is less than 100 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 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements. Resistance to ground for electrical system shall not exceed 5 ohms measurement and additional grounding shall be provided to attain this value or lower.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance 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.

B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 5 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: 5 ohm.
5. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

B. Related Sections include the following:
   1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

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

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. 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. Equipment supports.

C. QUALITY ASSURANCE

D. Comply with NFPA 70.

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 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Allied Tube & Conduit.
      a. Cooper B-Line, Inc.; a division of Cooper Industries.
      b. ERICO International Corporation.
      c. Thomas & Betts Corporation.
      d. Unistrut; Tyco International, Ltd.
      e. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Mechanical-Expansion Anchors: Insert-wedge-type, 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   2. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   4. Toggle Bolts: All-steel springhead type.
   5. Hanger Rods: Threaded steel.

G. Lighting Fixtures
   1. Suspended Acoustical Ceiling System
      a. Support recessed fluorescent fixtures from building structure with yellow colored steel support wires, two (2) ten gauge at diagonal corners or four (4) twelve gauge at four corners. Allow 1/4-inch slack in wires. Attach fixtures positively to ceiling members with attachments having a capacity of 100% of the fixture weight in all directions.
      b. Support fixtures weighting over 50 pounds directly from the structure with approved hangars, and attach fixture positively to ceiling members. Support hangars to be colored yellow.
      c. Attach surface fixtures to main runners with a minimum of two approved clamping devices and support each clamp from ceiling structure with yellow colored the gauge steel wire.
   2. Pendant Mounted Fixtures: Provide approved seismic suspension allowing 45 degree swing in all directions without hitting obstruction or provide steel support cable concealed in hangars. If 45 degree free swing can not be maintained, brace fixtures to preclude contact with adjacent structure or material.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: 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 (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. SUPPORT INSTALLATION

E. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

F. 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.

G. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

H. 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 Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
5. To Light Steel: Sheet metal screws.
6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

I. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.2 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.

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 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.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION

SECTION 260533 - RACEWAYS 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. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.
   2. For handholes and boxes for underground wiring, including the following:
      a. Duct entry provisions, including locations and duct sizes.
      b. Frame and cover design.
      c. Grounding details.
      d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
      e. Joint details.

C. Samples for Initial Selection: For wireways and surface raceways with factory-applied texture and color finishes.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. O-Z Gedney; a unit of General Signal.
   7. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket.

I. 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, compression type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

J. 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.

4. CANTEX Inc.
5. Lamson & Sessions; Carlon Electrical Products.
6. RACO; a Hubbell Company.
7. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVCunless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 112, 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: Hinged type as indicated.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Thomas & Betts Corporation.
b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper 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. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum or galvanized, cast iron with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
   1. Color of Frame and Cover: 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. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   6. 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.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. CDR Systems Corporation.

2.7 SLEEVES FOR RACEWAYS

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

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

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch 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."

2.8 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   2. 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 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit orIMC.
   2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC orEMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: Rigid steel conduit IMC or EMT.
   2. Exposed, Not Subject to Severe Physical Damage: Rigid steel conduit IMC or EMT.
   3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Electrical rooms.
      e. Parking structures or parking areas.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: Rigid steel conduit or IMC.
   7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.

8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway.
9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Do not install aluminum conduits in contact with concrete.

3.2 RACEWAY SEPARATION OF SYSTEM WIRING

A. Provide minimum separations between power and wiring and signal system wiring as indicated in table below. Where minimum separation can not be maintained due to existing conditions obtain written permission for closer spacing.

	Power Raceways (70 Volts or More)	Transformers, Motors and Motor Starters	Power Raceways with Dimming Circuits	Lighting Fixtures
Telephone	5"	12"	24"	12"
Data	5"	12"	24"	12"
Paging / Sound	5"	12"	24"	5"
Security	5"	12"	24"	5"
CCTV	5"	12"	24"	5"
Monitoring and Control	5"	12"	24"	5"
Fire Alarm	5"	12"	24"	5"
Cable Tray	12"	24"	24"	12"

3.3 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.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs
   1. Conduit installation is not acceptable unless approved by Architect prior to installation. If acceptable the following applies:
      a. Run conduit parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Maximum size as accepted by Architect.
      b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

I. 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.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
   1. 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.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where otherwise required by NFPA 70.

N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.

O. 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.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.4 INSTALLATION OF UNDERGROUND CONDUIT

A. Encased Conduit
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
   2. Use precast or plastic separators to secure uniform spacing between conduits of 2".

3. After installing conduit, encase raceways in concrete envelope of rectangular cross section not less than 3" beyond any surface of conduit. Where steel conduit extends above grade from concrete encasement, paint conduit with two coats of bitumastic paint for 12 inches minimum both sides of junction with concrete.
4. After installing the concrete encasement, mandrel conduits with steel ball mandrel prior to complete backfilling. Replace all raceways that can not be mandreled.
5. 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.
6. Warning Planks: Bury warning planks approximately 12 inches above encased conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

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 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. 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 unless sleeve seal is to be installed or unless seismic criteria require different clearance.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. 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.

J. 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."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

L. 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.

M. 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.

3.6 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.

3.7 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."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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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 aluminum cable trays and accessories.

1.3 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   2. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the State of California, who is responsible for their preparation.
      a. Design Calculations: Calculate requirements for selecting seismic restraints.
      b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

C. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
   1. Vertical and horizontal offsets and transitions.
   2. Clearances for access above and to side of cable trays.
   3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

D. Field quality-control reports. Contractor to provide one field quality report after installation and before architectural finishes are applied.

E. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components 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 NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. PW Industries.
   2. Cooper B-Line, Inc.
   3. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
   4. Chalfant Manufacturing Company.

2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with Type 316 stainless-steel splice-plate fasteners, bolts, and screws.

B. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
   1. Center-hanger supports may be used only when specifically indicated.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports to building structure and install seismic restraints.
   1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

2. Place supports so that spans do not exceed maximum spans as per manufacturer's requirements.
3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
4. Support bus assembly to prevent twisting from eccentric loading.
5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
6. Locate and install supports according to NEMA VE 1.

D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.

F. Make changes in direction and elevation using standard fittings.

G. Make cable tray connections using standard fittings.

H. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

I. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

J. Workspace: Install cable trays with enough space to permit access for installing cables.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

L. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.2 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every 18 inches (457 mm). Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. In existing construction, remove inactive or dead cables from cable tray.

E. Install covers after installation of cable is completed.

3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:
   1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
   2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
   3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
   4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
   5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
   6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

3.5 PROTECTION

A. Protect installed cable trays.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.
   3. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION

SECTION 260548 - 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

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.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

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 and seismic restraints.
      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
   2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
   3. Field-fabricated supports.
   4. Seismic-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

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. Qualification Data: For professional engineer and testing agency.

F. 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 nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

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

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

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

E. Comply with NFPA 70.

1.6 QUALITY CONTROL

A. Contractor is responsible for testing and surveying as required for quality control purposes.

1.7 ISOLATOR CONFIGURATION FOR FLOOR MOUNTED OR SUSPENDED EQUIPMENT.

A. A maximum of four vibration isolators shall be provided, located at the corners of the equipment unless approval is obtained for additional isolators.

B. Mounting frames and/or brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.

C. Installation of flexible electrical connections to vibration isolated equipment shall in no way impair or restrain the function of the aforementioned vibration isolation.

1.8 SEISMIC RESTRAINT REQUIREMENTS

A. Seismic restraint shall be furnished and installed in accordance with all relevant State and local Code requirements. Seismic restraint and anchoring details shall be provided by structural engineer.

1.9 VIBRATION ISOLATION REQUIREMENTS.

Contractor and vibration isolation manufacturer shall have the following responsibilities:

A. To determine vibration isolation sizes and locations.
B. To provide equipment isolation system as scheduled or specified.
C. To guarantee specified isolation system deflection.
D. To provide installation instructions and drawings.
E. To provide calculations signed by a structural engineer licensed in the State in which the work is to take place certifying that the seismic restraints will act in accordance with the relevant State and local codes and will maintain equipment in captive position.
F. To provide approved resilient restraining devices as required to limit transformer motion in excess of 3/8 inch.
G. To provide signature of a licensed structural engineer for all calculations on the seismic snubber.

2.0 VIBRATION ISOLATION AND NOISE CONTROL REQUIREMENTS.

A. Floor Mounted Transformers.

1. Type E, 0.15 inch static deflection.
2. Locate at 4 corners of transformer.
3. Bolt to floor.
4. Wall mounted not permitted.

B. Flexible Electrical Connections.

1. At all transformers within building.
2. At connections to motors or other vibrating equipment.

2.1 ELECTRICAL BOX PADS.

A. Provide at all junction boxes located within sound insulated drywall partitions.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

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

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.

6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

D. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene .

2.2 SEISMIC-RESTRAINT DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Amber/Booth Company, Inc.
   2. California Dynamics Corporation.
   3. Cooper B-Line, Inc.; a division of Cooper Industries.
   4. Hilti Inc.
   5. Loos & Co.; Seismic Earthquake Division.
   6. Mason Industries.
   7. TOLCO Incorporated; a brand of NIBCO INC.
   8. Unistrut; Tyco International, Ltd.

D. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

E. 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.

F. 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.

G. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

H. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

I. 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.

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

K. 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.

L. 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 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. 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.

2.4 VIBRATION ISOLATORS.

A. General Properties

1. All vibration isolators shall have either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

2. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range 50% above the design deflection.

3. The ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 2.0.

4. The vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ by more than + or - 10%.

5. All vibration isolation equipment exposed to moisture or an outdoor environment shall be coated as follows:

a. All steel parts to be hot-dipped galvanized.

b. All bolts to be cadmium plated.

c. All springs to be cadmium plated and neoprene coated.

B. Isolator Types and Descriptions.

Type E is a neoprene isolator capable of resisting a seismic load of 1.0 G in all directions. The mount shall consist of a captive steel insert embedded into a neoprene element that is enclosed by a steel housing which also includes floor mounting holes. The isolator shall have a rated deflection of 0.15 inches in compression, 0.12 inches in tension and 0.09 inches in shear.

2.5 FLEXIBLE CONNECTIONS.

A. Conduit over 1 inch OD: Make electrical connections to vibrating equipment via flexible expansion/deflection conduit coupling sized as required. Coupling shall have a flexible and watertight outer jacket, an internal grounding strap, plastic inner sleeve to maintain smooth wireway and end hubs with threads to fit standard threaded metal conduit. Acceptable units include:

1. XD Expansion Deflection Coupling by Crouse-Hinds of Syracuse, N.Y.

2. Type DF Expansion and Deflection fitting by Spring City Electrical Mfg. Co. of Spring City, PA.

B. For conduit under 1 inch OD: Use "flexible" conduit with slack at least 3 feet or 15 diameters long, whichever is the longer or provide a flexible coupling as defined above.

2.6 ELECTRICAL BOX PADS.

A. Equal to Lowry's Outlet Box Pads as manufactured by Harry A. Lowry Associates, Sun Valley, California.

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 by an agency acceptable to authorities having jurisdiction.

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

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

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

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

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

D. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.
   6. Measure isolator restraint clearance.
   7. Measure isolator deflection.
   8. Verify snubber minimum clearances.
   9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

F. Contractor is responsible for testing and surveying as required for quality control purposes.

3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

SECTION 260553 - 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. This Section includes the following:
   1. Identification for raceway .
   2. Identification for power and control cable.
   3. Underground-line warning tape.
   4. Warning labels and signs.
   5. Instruction signs.
   6. Equipment identification labels.
   7. Miscellaneous identification products.

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.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, 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 and cable size.

B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 inches wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.

2.4 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: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. 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."
   3.

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. 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.

2.6 EQUIPMENT IDENTIFICATION LABELS

To match existing tags for electrical equipmentStenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
   1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
      a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior concrete and masonry primer.
         2) Finish Coats: Exterior semigloss acrylic enamel.
   2. Exterior Concrete Unit Masonry:
      a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
         1) Block Filler: Concrete unit masonry block filler.
         2) Finish Coats: Exterior semigloss acrylic enamel.
   3. Exterior Ferrous Metal:
      a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior ferrous-metal primer.
         2) Finish Coats: Exterior semigloss alkyd enamel.
   4. Exterior Zinc-Coated Metal (except Raceways):
      a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior zinc-coated metal primer.
         2) Finish Coats: Exterior semigloss alkyd enamel.
   5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
      a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Interior concrete and masonry primer.
         2) Finish Coats: Interior semigloss alkyd enamel.
   6. Interior Concrete Unit Masonry:
      a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

1) Block Filler: Concrete unit masonry block filler.
2) Finish Coats: Interior semigloss acrylic enamel.

7. Interior Gypsum Board:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior gypsum board primer.
      2) Finish Coats: Interior semigloss acrylic enamel.
8. Interior Ferrous Metal:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior ferrous-metal primer.
      2) Finish Coats: Interior semigloss acrylic enamel.
9. Interior Zinc-Coated Metal (except Raceways):
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior zinc-coated metal primer.
      2) Finish Coats: Interior semigloss acrylic enamel.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 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 and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label .

D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
   1. Fire Alarm System: Red.
   2. Fire-Suppression Supervisory and Control System: Red and yellow.
   3. Combined Fire Alarm and Security System: Red and blue.
   4. Security System: Blue and yellow.
   5. Mechanical and Electrical Supervisory System: Green and blue.
   6. Telecommunication System: Green and yellow.
   7. Control Wiring: Green and red.
   8.

E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape . Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape . Identify each ungrounded conductor according to source and circuit number.

G. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data 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 Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels . Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. 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.
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Instruction Signs:
   1. Operating Instructions: 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.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer .

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   2. Equipment to Be Labeled:
      a. Panelboards, electrical cabinets, and enclosures.
      b. Access doors and panels for concealed electrical items.
      c. Electrical switchgear and switchboards.

d. Transformers.
e. Electrical substations.
f. Emergency system boxes and enclosures.
g. Disconnect switches.
h. Enclosed circuit breakers.
i. Motor starters.
j. Push-button stations.
k. Remote-controlled switches, dimmer modules, and control devices.
l. Battery inverter units.
m. Battery racks.
n. Voice and data cable terminal equipment.
o. Fire-alarm control panel and annunciators.
p. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
q. Monitoring and control equipment.
r. Uninterruptible power supply equipment.
s. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 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 nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Neutral: White
      e. Ground: Green
   3. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Grey
      e. Ground: Green
   4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two

turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

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: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION

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SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION 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.
   1. Series-rated devices is not permitted on this project
   2. Short currents analysis and recommendation report shall be submitted prior to spec sections 26 24 13 and 26 24 16

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for Power System Analysis and Protective Coordination Study .
   a. Computer software-use SKM Systems 'Dapper' version 3.5 and 'Captor' version 3.5 programs. In addition to the software generated printouts, produce a short circuit device evaluation table including the bus number, bus name, phase and ground fault currents, X/R ratio, 110% of the calculated fault current, bus bracing and AIC rating of the devices on the bus.

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.
   a. Qualifications for Power System Analysis-Study to be performed by an independent, third party firm not involved in the supply of the equipment nor involved in the final field testing and setting of this project.
   b. The firm should be currently involved in high and low voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of California. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Architect for approval prior to start of the work. A minimum of 15 years experience is power system is required for the individual in charge of the project.
   c. The firm performing the study should demonstrate capability and experience to provide assistance during start up if required or if called for. The individual involved of the study work should have proven field experience. The individual in charge should be aware of the most recent ANSI/IEEE changes and familiar with standards C37.010, C37.16, IEEE-242, IEEE-446, IEEE-399 AND IEEE-141

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may 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.

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 Section 1.3 (a) above. 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. See Section 1.3 (C) above.
   1. Professional engineer, licensed in the state of California, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Contractor is responsible for testing and surveying as required for quality control purposes.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. SKM Systems Analysis, Inc.
   2. CGI CYME.
   3. EDSA Micro Corporation.
   4. ESA Inc.
   5. Operation Technology, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

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. Devices to be coordinated are indicated on Drawings. See electrical single line diagram for device ratings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

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 hard-copy and electronic-copy formats, showing the following:
      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. Time-current-characteristic curves of devices indicated to be coordinated.
      f. 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.
      g. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
      h. 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. Medium-voltage controller.
3. Distribution panelboard.
4. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with 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 interrupting (5-cycle) 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. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. 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.

D. 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.

E. 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.
   f. Contractor responsible to ensure that installed breakers are correctly set at the time of installation.
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.
3. Implementation of Short Circuit and Protective Device coordination studies results.
   a. Upgrading and modifications to equipment characteristic and ratings shall be finalized by the results of the short circuit and protective device coordination studies.
   b. Field setting of devices, adjustments upgrading and modifications to the new equipment to accomplish conformance with the accepted short circuit and protective device coordination studies, shall be carried out by the contractor as part of the scope of work.

F. Completed data sheets for setting of overcurrent protective devices.

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SECTION 260923 - 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. Section Includes:
1. Standalone daylight-harvesting switching and dimming controls.
2. Indoor occupancy and vacancy sensors.
3. Switchbox-mounted occupancy sensors.
4. Digital timer light switches.
5. High-bay occupancy sensors.
6. Outdoor motion sensors.
7. Lighting contactors.
8. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment will be attached.
3. Items penetrating finished ceiling, including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Control modules.

B. Field quality-control reports. Provide two reports, one after installation but before architectural finishes are applied and one after complete installation but prior to occupancy. Report to contain data regarding programming of lighting control devices.

C. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On manufacturer's website. Provide names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Faulty operation of lighting control software.
    b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Watt Stopper.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

a. When no daylight is present (target level).
b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

a. Initial setup tool.
b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

E. Power Pack: Digital controller capable of accepting 4 RJ45 inputs with two outputs rated for 13-A ballast load or LED at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

1. With integral current monitoring

a. Compatible with digital addressable lighting interface.

1) Plenum rated.

2.2 INDOOR OCCUPANCYAND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. Sensor Switch, Inc.
7. Watt Stopper.

B. General Requirements for Sensors:

1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Separate power pack.
4. Hardwired connection to switch; and BAS and lighting control system.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation:
   a. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
7. Sensor Output: Sensor is powered from the power pack.
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20-A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:
    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. Sensor Switch, Inc.
7. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Switch Rating: Not less than 800-VA ballast or LED load at 120 V, 1200-VA ballast or LED load at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Dual voltage - 120 and 277 V.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

9. Color: White.
10. Faceplate: Color matched to switch.

2.4 HIGH-BAY OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Hubbell Building Automation, Inc.

B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
4. Power: Line voltage.
5. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
6. Mounting: Threaded pipe.
7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Detector Technology: PIR.
9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor.

C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).

D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.5 OUTDOOR MOTION SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Sensor Switch, Inc.
6. Watt Stopper.

B. General Requirements for Sensors: Solid-state outdoor motion sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24.
2. Dual-technology (PIR and infrared) type, weatherproof. Detect occurrences of 6-inch-(150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
3. Switch Rating:

    a. Luminaire-Mounted Sensor: 1000-W incandescent, 500-VA fluorescent/LED.
    b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

4. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off." With bypass switch to override the "on" function in case of sensor failure.
5. Voltage: Dual voltage, 120- and 277-V type.
6. Detector Coverage:

    a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
    b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.

7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
10. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.

2.6 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design.
2. Watt Stopper.

B. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 277 V.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "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 Section 260519 "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 Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. 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 systems, and partition assemblies.

C. 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.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. 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.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Contractor is responsible for testing and surveying as required for quality control purposes.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. One 8 hour session of training is required.

END OF SECTION 260923

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.

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. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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.

D. Qualification Data: For testing agency. Contractor to provide qualifications data for testing agency. Qualifications to be reviewed and approved by the owner.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain each transformer 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 IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

E. Contractor is responsible for testing and surveying as required for quality control purposes.

1.5 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. Available Manufacturers: Subject to compliance with requirements, provide General Electric Company.

B. Or provide as alternate price options:

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. Square D; Schneider Electric.
3. Siemens

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. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 49 gray.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

G. 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.

H. Fungus Proofing: Permanent fungicidal treatment for coil and core.

I. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40dBA
2. 30 to 50 kVA: 45dBA
3. 51 to 150 kVA: 50dBA
4. 151 to 300 kVA: 55dBA
5. 301 to 500 kVA: 60dBA
6. 501 to 750 kVA: 60dBA
7. 751 to 1000 kVA: 60dBA

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

K. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

L. Include special terminal for grounding the shield.

M. Shield Effectiveness:

N. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

O. 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.

P. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

Q. Fungus Proofing: Permanent fungicidal treatment for coil and core.

R. 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 HARMONIC MITIGATION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: zig-zag.

D. Enclosure: Ventilated, NEMA 250, Type 2.

E. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

H. Energy Efficiency for Transformers Rated 15 kVA and Larger:

I. Energy certified.

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

K. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

L. Include special terminal for grounding the shield.

M. Shield Effectiveness:

N. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

O. 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.

P. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

Q. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution 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. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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."

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. Report results in writing.

B. 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.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after Substantial Completion, 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 262300 - LOW-VOLTAGE SWITCHGEAR

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 metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Service.

B. GFCI: Ground-fault circuit interrupter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each type of switchgear and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

    a. Tabulation of installed devices with features and ratings.
    b. Enclosure types and details.
    c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
    d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
    e. Current rating of buses.
    f. Short-time and short-circuit current rating of switchgear assembly.
    g. Nameplate legends.
    h. Mimic-bus diagram.
    i. Utility company's metering provisions with indication of approval by utility company.
    j. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For testing agency.

D. Field quality-control test reports. Provide one report at time of installation.

E. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
2. Indicating Lights: Six of each type installed.
3. Touchup Paint: 3 containers of paint matching enclosure finish, each 0.5 pint (250 mL).

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Section 016000 "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Contractor is responsible for testing and surveying as required for quality control purposes.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.10 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

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 Construction Manager no fewer than thirty days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 40 deg C.
2. Altitude: Not exceeding 6600 feet (2010 m).

1.11 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Inc.
2. Cutler-Hammer, Inc.
3. General Electric Company.
4. Siemens Industry, Inc.
5. Square D; by Schneider Electric.

2.2 RATINGS

A. Nominal System Voltage: 480/277 V, 4 wire, 60 Hz.

B. Main-Bus Continuous: 3200 A.

C. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

2.3 FABRICATION

A. Factory assembled and tested and complying with IEEE C37.20.1.

B. Indoor Enclosure Material: Steel.

C. Outdoor Enclosure Material: Galvanized steel.

D. Outdoor Enclosure Fabrication Requirements: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating; and each compartment equipped with the following features:

1. Structural design and anchorage adequate to resist loads imposed by 125-mph (200-km/h) wind.
2. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
3. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
4. Hinged front door with padlocking provisions.
5. Interior light with switch.
6. Weatherproof duplex receptacle.
7. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
8. Aisle access doors with outside padlocking provisions and interior panic latches.
9. Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.
10. Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.
11. GFCI duplex receptacles, a minimum of two, located in aisle.
12. Aisle ventilation louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding insects, rodents, and exterior dust.

E. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

F. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.

G. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.

H. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.

I. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.

J. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:

1. Utility metering compartment that complies with utility company requirements.
2. Bus transition sections.
3. Incoming-line pull sections.
4. Hinged front panels for access to metering, accessory, and blank compartments.
5. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

    a. Set pull box back from front to clear circuit-breaker lifting mechanism.
    b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
    c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

K. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.

1. Main Phase Bus: Uniform capacity the entire length of assembly.
2. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
4. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
5. Use copper for connecting circuit-breaker line to copper bus.
6. Contact Surfaces of Buses: Silver plated.
7. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches (6 by 50 mm).
9. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
10. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
11. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch (6-by-50-mm) copper bus, arranged to connect neutral bus to ground bus.
12. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
13. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.

a. Sprayed Insulation Thickness: 3 mils (0.08 mm), minimum.
b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

2.4 COMPONENTS

A. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.

B. Analog Instruments: Rectangular, 4-1/2-inch (115-mm) square, accurate within 1 percent, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment, complying with ANSI C39.1.

1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a. Operation: Meter counts and records a succession of pulses entering two channels.
b. Housing: Drawout, back-connected case arranged for semiflush mounting.

C. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

D. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11 and NEMA LA 1.

1. Install in cable termination compartments and connect in each phase of circuit.
2. Coordinate rating with circuit voltage.

E. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

F. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.

G. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:

1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.

    a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
    b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.

3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
4. Fuses are specified in Section 262813 "Fuses."

H. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2. Conductors sized according to NFPA 70 for duty required.

2.5 CIRCUIT BREAKERS

A. Description: Comply with IEEE C37.13.

B. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

1. Normal Closing Speed: Independent of both control and operator.
2. Slow Closing Speed: Optional with operator for inspection and adjustment.
3. Stored-Energy Mechanism: Electrically charged, with optional manual charging.
4. Operation counter.

D. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
3. Field-adjustable, time-current characteristics.
4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.

5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I^2t operation.
7. Pickup Points: Five minimum, for instantaneous-trip functions.
8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:

    a. Three-wire circuit or system.
    b. Four-wire circuit or system.
    c. Four-wire, double-ended substation.

9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

F. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:

    a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
    b. Disconnected Position: Primary and secondary devices and ground contact disengaged.

G. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

H. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

I. Operating Handle: One for each circuit breaker capable of manual operation.

J. Electric Close Button: One for each electrically operated circuit breaker.

K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

L. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.

M. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage.

N. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

O. Shunt-Trip Devices: Where indicated.

P. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:

1. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
2. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
3. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.
4. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.

Q. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.6 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

1. Racking handle to manually move circuit breaker between connected and disconnected positions.
2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.

C. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

D. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

E. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.7 IDENTIFICATION

A. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as selected by Architect.
3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

B. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:

1. Frame size of each circuit breaker.
2. Trip rating for each circuit breaker.
3. Conduit and wire size for each feeder.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable portions of NECA 400.

B. Anchor switchgear assembly to 4-inch (100-mm), channel-iron floor sill embedded in concrete base and attach by bolting.

1. Sills: Select to suit switchgear; level and grout flush into concrete base.
2. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548.16 "Seismic Controls for Electrical Systems" for seismic-restraint requirements.
3. Concrete Bases: 6 inches (150 mm) high, reinforced, with chamfered edges. Extend base no more than 6 inches (150 mm) in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support.

Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Diagram and Instructions:

1. Frame and mount under clear acrylic plastic on the front of switchgear.

   a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
   b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear 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 switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in electrical Sections.
3. Complete installation and startup checks according to manufacturer's written instructions.

4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
5. Report results in writing.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:

   a. Switchgear.
   b. Circuit breakers.
   c. Protective relays.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.

2. Remove and replace malfunctioning units and retest as specified above.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Section 260573 "Overcurrent Protective Device Coordination Study."

B. Set field-adjustable, protective-relay trip characteristics. Contractor to set adjustments per engineering drawings and the results of the coordination study.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 262300

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.

2. Transient voltage suppression devices.

3. Disconnecting and overcurrent protective devices.

4. Instrumentation.

5. Control power.

6. Accessory components and features.

7. Identification.

8. Mimic bus.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards 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 and the unit will be fully operational after the seismic event.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

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.

2. Detail enclosure types for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.

6. Detail utility company's metering provisions with indication of approval by utility company.

7. Include evidence of NRTL listing for series rating of installed devices.

8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

10. Include diagram and details of proposed mimic bus.

11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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 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.

F. Operation and Maintenance Data: For switchboards 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 switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing. Contractor to supervise testing and review test results for compliance.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and connect factory-installed space heaters to temporary electrical service to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weather tight, wet work in spaces is complete and dry, work above switchboards 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.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

D. 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 Owner no fewer than five 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 Owner's written permission.

4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards 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 Substantial Completion.

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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type. Refer to electrical single line diagram for quantities and ratings.

3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

6. Indicating Lights: 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 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide: General Electric Company.

B. Or provide as alternate pricing:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. Siemens Energy & Automation, Inc.

3. Square D; a brand of Schneider Electric.

C. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel mounted.

2. Branch Devices: Panel mounted.

3. Sections front and rear aligned.

D. Nominal System Voltage: 480Y/277 V and 208Y/120 V.

E. Main-Bus Continuous: 800A

F. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

G. Indoor Enclosures: Steel, NEMA 250, Type 1.

H. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

I. Barriers: Between adjacent switchboard sections.

J. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

K. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.

L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

M. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.

2. Set back from front to clear circuit-breaker removal mechanism.

3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.

4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.

5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

N. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with tin-plated aluminum or copper feeder circuit-breaker line connections.

2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

3. Ground Bus: **1/4-by-2-inch- (6-by-50-mm-)** hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

P. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

Q. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

   a. Instantaneous trip.

   b. Long- and short-time pickup levels.

   c. Long- and short-time time adjustments.

   d. Ground-fault pickup level, time delay, and I2t response.

4. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
5. GFCI Circuit Breakers: Single- and two-pole configurations with 5 -mA trip sensitivity.
6. All Breakers shall be 100% rated and have solid-state trip unit with minimum seven functions complete with built-in current transformers. Breakers shall have easily changed trip rating plugs with trip ratings as indicated on the Drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that breaker cannot be latched with rating plug removed. Breaker shall have built-in test points for testing long delay and instantaneous, and ground fault (where shown) functions of the breaker by means of a 120-volt operated test kit. Provide one test kit capable of testing all breakers 600 AMP and above. Solid state trip shall be with long time rating, long and short time delay, independently adjustable long and short time pick-up, and adjustable instantaneous pick-up.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

C. Fuses are specified in Division 26 Section "Fuses."

2.3 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, double tapped secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

2.4 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control Circuits: 120-V ac, supplied from remote branch circuit.

C. Control Circuits: 24-V dc.

D. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

E. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

F. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

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 switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.6 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.

1. Nameplate: At least 0.0625-inch- (1.588 mm-) thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.

C. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

D. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

E. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

F. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards 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 switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) 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 (450-mm) centers around the full perimeter of concrete base.

2. For supported equipment, 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 switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with

requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

E. 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 switchboard. 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 switchboard 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.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Switchboard will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

H. Contractor is responsible for testing and surveying as required for quality control purposes.

3.6 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 indicated. Contractor to set breaker trips in accordance with project documents and coordination study.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units. Provide 8 hour training for facilities maintenance personel.

END OF SECTION 262413

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards 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 and the unit will be fully operational after the seismic event.

1.5 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: For installation in panelboards. Submit final versions after load balancing.

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.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. 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.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

G. Contractor is responsible for testing and surveying as required for quality control purposes.

1.7 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.

1.8 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 minus 22 deg F 23 deg F to plus 120 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 Owner no fewer than three days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Owner's written permission.

3. Comply with NFPA 70E.

1.9 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.

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.

1.10 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 Substantial Completion.

1.11 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. Keys should be identified with labels.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: 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.

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: 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: Galvanized steel.

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.

C. Incoming Mains Location: as recommended.

D. 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.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Mechanical type.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

6. Gutter-Tap Lugs: Mechanical 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.

F. 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.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION LIGHTING/APPLIANCE PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide: General Electric Company.

B. Provide as alternate pricing

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. Siemens Energy & Automation, Inc.

3. Square D; a brand of Schneider Electric.

C. Panelboards: NEMA PB 1, power and feeder distribution type.

D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than **36 inches** high, provide two latches, keyed alike.

E. Mains: Circuit breaker.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.

G. 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.

H. Branch Overcurrent Protective Devices: Fused switches.

I. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2. External Control-Power Source: 120-V branch circuit

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide General Electric Company:

B. Or provide as alternate pricing:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. Siemens Energy & Automation, Inc.

3. Square D; a brand of Schneider Electric.

C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

D. Mains: Circuit breaker

E. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

F. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2. External Control-Power Source: 120-V branch circuit.

G. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

H. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide General Electric Company.

B. Or provide as alternate pricing:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. Siemens Energy & Automation, Inc.

3. Square D; a brand of Schneider Electric.

C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating, interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.

   b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.

   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

   e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."

   f. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

   g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional field-adjustable 0.1- to 0.6-second] time delay.

   h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.

   i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.

   j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

   k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.

   l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."

2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

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. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) 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 (450-mm) 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 (2286 mm)** above finished floor unless otherwise indicated.

F. 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.

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 (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

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; 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. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

E. 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.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. 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. Contractor to hire testing agency for panelboard tests and prepare certified report.

H. Contractor is responsible for testing and surveying as required for quality control purposes.

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 the 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 262416

SECTION 262713 - ELECTRICITY METERING

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 equipment for electricity metering by utility company and electricity metering by Owner.

1.3 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports. Provide one report by approved testing agency hired by contractor.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.

2. Software licenses.
3. Software service agreement.
4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than thirty days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets: Comply with requirements of electrical-power utility company.

D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings. Refer to electrical single line diagram for ratings.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Corporation.
2. E-Mon.
3. General Electric Company.
4. Siemens Energy.
5. Square D; by Schneider Electric.

B. General Requirements for Owner's Meters:

1. Comply with UL 1244.
2. Meters used for billing shall have an accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20.
3. Meters shall be certified by California Type Evaluation Program as complying with Title 4, California Code of Regulations, Article 2.2.
4. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
5. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
6. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
7. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: Split and solid core.

8. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

C. Kilowatt-hour Meter: Electronic three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kilowatt-hours.

D. Kilowatt-hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.

3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262713

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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. Snap switches and wall-box dimmers.
   7. Wall-switch and exterior occupancy sensors.
   8. Pendant cord-connector devices.
   9. Cord and plug sets.
   10. Floor service outlets, poke-through assemblies, 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.

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. Provide test reports by manufacturer or manufacturer approved testing agency.

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. Floor Service Outlet Assemblies: One for every 10.
   2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

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.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 5351 (single), 5352 (duplex).
      b. Hubbell; HBL5351 (single), CR5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; CR 5253IG.
      b. Leviton; 5362-IG.
      c. Pass & Seymour; IG6300.
   2. 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.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-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:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; GF20.
      b. Pass & Seymour; 2084.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; L520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.

2.5 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.

2.6 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
      b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
      c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
      d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221PL for 120 V and 277 V.
      b. Hubbell; HPL1221PL for 120 V and 277 V.
      c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
      d. Pass & Seymour; PS20AC1-PLR for 120 V.
   2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221L.

b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 1995.
   b. Hubbell; HBL1557.
   c. Leviton; 1257.
   d. Pass & Seymour; 1251.

F. 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.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 1995L.
   b. Hubbell; HBL1557L.
   c. Leviton; 1257L.
   d. Pass & Seymour; 1251L.

2.7 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider ; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.8 OCCUPANCY SENSORS

A. Wall-Switch Sensors

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 6111 for 120 V, 6117 for 277 V.
   b. Hubbell; WS1277.
   c. Leviton; ODS 10-ID.
   d. Pass & Seymour; WS3000.
   e. Watt Stopper (The); WS-200.

2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

B. Long-Range Wall-Switch Sensors

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; ATP1600WRP.
   b. Leviton; ODWWV-IRW.
   c. Pass & Seymour; WA1001.
   d. Watt Stopper (The); CX-100.

2. 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..

C. Long-Range Wall-Switch Sensors
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell; ATD1600WRP.
b. Leviton; ODW12-MRW.
c. Watt Stopper (The); DT-200.
2. 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..

D. Wide-Range Wall-Switch Sensors
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell; ATP120HBRP.
b. Leviton; ODWHB-IRW.
c. Pass & Seymour; HS1001.
d. Watt Stopper (The); CX-100-3.
2. 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..

E. Exterior Occupancy Sensors
1. Products: Subject to compliance with requirements, provide one of the following:
a. Leviton; PS200-10.
b. Watt Stopper (The); EW-100-120.
2. 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.

2.9 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 .
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.10 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type , dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

2.11 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.

2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Square D/ Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold Company (The).

B. 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: Flush type with four simplex receptacles and space for four RJ-45 jacks.
2. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
3. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
4. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.12 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Wire: No. 12 AWG.

2.13 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: White As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 EXECUTION

3.1 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 insure 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.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. 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.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black -filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436.
2. 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.

END OF SECTION

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. Cartridge fuses rated 600 V and less for use in switches.
   2. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   2. Let-through current curves for fuses with current-limiting characteristics.
   3. Time-current curves, coordination charts and tables, and related data.
   4. Fuse size for elevator feeders and elevator disconnect switches.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.5 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.

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. Fuses: Quantity equal to 10 percent of each fuse type and size, but no fewer than 2 of each type and size.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussman, Inc.
2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
3. Ferraz Shawmut, Inc.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE-FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch- thick 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.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK1 and RK5, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

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. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers.
4. Molded-case switches.
5. Enclosures.

1.3 DEFINITIONS

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. HD: Heavy duty.

D. RMS: Root mean square.

E. 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, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports including the following:

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.

E. Manufacturer's field service report providing test results for switches and circuit breakers showing correct operation.

F. 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 curves, including selectable ranges for each type of circuit breaker.

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. 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.

1.6 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. General Electric Co.; Electrical Distribution & Control Division.
2. Eaton Corporation; Cutler-Hammer Products.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Fusible Switch, 1200 A and Smaller: NEMA KS 1, Type GD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 1200 A and Smaller: NEMA KS 1, Type GD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. General Electric Co.; Electrical Distribution & Control Division.
2. Eaton Corporation; Cutler-Hammer Products.
3. Moeller Electric Corporation.
4. Siemens Energy & Automation, Inc.
5. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

   a. Instantaneous trip.

   b. Long- and short-time pickup levels.

   c. Long- and short-time time adjustments.

   d. Ground-fault pickup level, time delay, and I2t response.

4. GFCI Circuit Breakers: Single- and two-pole configurations with 5 -mA trip sensitivity.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

E. Molded-Case Switch Accessories:

1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. Provide "dummy" trip unit where required for proper operation.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

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.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as 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 field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

B. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Infrared Scanning:

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. Open or remove doors or panels so connections are accessible to portable scanner.

b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.

c. Instruments, Equipment and Reports:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges according to engineering drawings and coordination study.

3.6 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION

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 TVSSs for low-voltage power, control, and communication equipment.

B. Related Sections include the following:
   1. Section 26 27 26 – Wiring Devices for devices with integral TVSSs.
   2. Section 26 24 13 – Switchboards for factory-installed TVSSs.
   3. Section 26 24 16 – Panelboards for factory-installed TVSSs.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:
   1. UL 1283.
   2. UL 1449.

C. Field quality-control test reports, including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

D. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Section 01 60 00 – 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 IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

E. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advanced Protection Technologies, Inc.
2. Current Technology, Inc.
3. Cutler-Hammer, Inc.; Eaton Corporation.
4. General Electric Company.
5. Innovative Technology, Inc.
6. LEA International.
7. Leviton Mfg. Company Inc.
8. Liebert Corporation; a division of Emerson.

2.2 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect test, and adjust equipment installation, including connections and to assist in field testing Report results in writing.
1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Perform the following field tests and inspections and prepare test reports:
1. Complete startup checks according to manufacturer's written instructions.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

C. Remove and replace malfunctioning units and retest as specified above.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Section 01 79 00 – Demonstration and Training.

END OF SECTION

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SECTION 265119 - LED 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. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

D. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.

1. Include Samples of luminaires and accessories involving color and finish selection.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which equipment and or luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Ceiling-mounted projectors.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. Bulb shape complying with ANSI C79.1.

F. Lamp base complying with ANSI C81.61 or IEC 60061-1.

G. CRI of minimum 80. CCT of 4100 K or as indicated in the light fixtures schedule.

H. Rated lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 277 V ac.

1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

L. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish, unless otherwise noted in lighting fixtures schedule.

M. Meet CEC Title 24 Luminaire efficacy.

N. Refer to drawings Sheet E7.01 for lighting fixture schedule basis of design.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. 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.

C. Diffusers and Globes:
1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Refer to electrical drawings sheets E6.01-E6.02 for mounting details.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

F. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

G. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

H. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
2. Ceiling mount with hook mount.

I. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT 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. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each product and for each color and texture specified.

D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.
3. Refer to lighting fixture schedule on sheet E7.01.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which equipment will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Ceiling-mounted projectors.
e. Sprinklers.
f. Access panels.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of luminaire.

D. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
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. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

B. 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 Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
2. Warranty Period for Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
2. 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.
3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.

b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
c. Humidity: More than 95 percent (condensing).
d. Altitude: Exceeding 3300 feet (1000 m).

4. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.
5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire 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.

6. Battery: Sealed, maintenance-free, nickel-cadmium type.
7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
8. Remote Test: Switch in handheld 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 a flashing red LED.

I. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
2. 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.
3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Remote Test: Switch in handheld 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.

10. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Luminaires:
1. Refer to drawings Sheet E7.01 for lighting fixture schedule basis of design.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cooper Lighting, an Eaton business.
   b. Hubbell Industrial Lighting; Hubbell Incorporated.
   c. Lithonia Lighting; Acuity Brands Lighting, Inc.
   d. Philips Lighting Company.

2. Operating at nominal voltage of 277 V ac.
3. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
6. 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.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
1. Glass: Annealed crystal glass unless otherwise indicated.
2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing and heat sink.
2. Clear anodized finish.

E. Conduit: Electrical metallic tubing, minimum 3/4 inch (21 mm) in diameter.

2.6 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge batteries minimum of one hour and depress switch to conduct short-duration test.
2. Charge batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, batteries, signs, or luminaires that are defective.

a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265219

SECTION 265613 - LIGHTING POLES AND STANDARDS

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. Poles and accessories for support of luminaires.
2. Luminaire-lowering devices.

1.3 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete lighting fixture.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

1.4 ACTION SUBMITTALS

A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.

4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

C. Samples: For each exposed lighting pole, standard, and luminaire-supporting device and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Qualification Data: For Installer and testing agency.

C. Seismic Qualification Certificates: For lights, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
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.

D. Material Test Reports:

1. For each foundation component, by a qualified testing agency.
2. For each pole, by a qualified testing agency.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: Manufacturer's standard warranty.

H. Soil test reports

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for foundation testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below finished grade.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design pole foundation and pole power system.

B. Seismic Performance: Foundation and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: 1.0.

C. Structural Characteristics: Comply with AASHTO LTS-6-M.

D. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

E. Live Load: Single load of 500 lbf (2200 N) distributed according to AASHTO LTS-6-M.

F. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

G. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 90 mph (40 m/s).

a. Wind Importance Factor: 1.0.
b. Minimum Design Life: 25 years.
c. Velocity Conversion Factor: 1.0.

H. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

I. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 STEEL POLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Lighting, an Eaton business.
2. EGS/Appleton Electric.
3. Hubbell Incorporated.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. LSI Corporation of America.

B. Source Limitations: Obtain poles from single manufacturer or producer.

C. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.

D. Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Square, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

E. Poles: Comply with ASTM A 240/A 240M, stainless steel with a minimum yield of 55,000 psig (379 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Square, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

F. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as plate.

G. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with galvanized-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

H. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

I. Fasteners: Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

J. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

K. Steps: Fixed steel, with nonslip treads.

1. For climbing positions, install at 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole, oriented 180 degrees from each other; first step shall be at an elevation 10 feet (3 m) above finished grade.
2. For working positions, install steps on opposite side of pole, oriented 180 degrees from each other at the same elevation.

L. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

M. Intermediate Handhole and Cable Support: Weatherproof, 3-by-5-inch (76-by-130-mm) handhole located at midpoint of pole, with cover for access to internal welded attachment lug for electric cable support grip.

N. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

O. Platform for Lamp and Ballast Servicing: Factory fabricated of steel, with finish matching that of pole.

P. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

Q. Galvanized Finish: After fabrication, hot-dip galvanize according to ASTM A 123/A 123M.

R. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

S. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Powder Coat: Comply with AAMA 2604.

    a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils dry film thickness. Coat interior and exterior of pole for equal corrosion protection.

b. Color: As selected by Architect from manufacturer's full range.

2.3 POLE ACCESSORIES

A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V ac, 20 A in a weatherproof assembly. Comply with requirements in Section 262726 "Wiring Devices."

1. Recessed 12 inches (300 mm) above finished grade.

a. NEMA 250, Type 4X, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.

B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

D. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept indicated accessories. Include removable flanged access cover secured with bolts or screws.

2.4 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi (380,000 kPa).

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Threading: Uniform National Coarse, Class 2A.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Four nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

C. Washers: ASTM F 436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Two washers provided per anchor bolt.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.

1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.

D. Direct-Buried Foundations: Install to depth indicated on Drawings, but not less than as indicated. Add backfill in 6-inch (150-mm) to 9-inch (230-mm) layers, tamping each layer before adding the next. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than as indicated. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.

2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

F. Anchor Bolts: Install plumb using manufacturer-supplied steel template, uniformly spaced.

3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. Fire Hydrants and Water Piping: 60 inches (1520 mm).
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2 -inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-(150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch (25 mm) below top of concrete slab.

F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.5 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Inspect poles for nicks, mars, dents, scratches, and other damage.
2. System function tests.

END OF SECTION 265613

SECTION 265619 – LED EXTERIOR 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. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project, IES LM-79 and IES LM-80.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer?s laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports and seismic restraints. Supports and restraints to be provided as per electrical drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: 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. Luminaires.
2. Structural members to which equipment and luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
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.

D. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

F. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. Bulb shape complying with ANSI C79.1.

G. CRI of minimum 80. CCT of 4100 K.

H. L70 lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 277 V ac.

L. In-line Fusing: On the primary for each luminaire.

M. Lamp Rating: Lamp marked for outdoor use.

N. Source Limitations: Obtain luminaires from single source from a single manufacturer.

O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE TYPES

A. Area and Site:

1. Formula
2. Luminaire Shape: **[Round]** **[Square]** **[Hexagonal]** **<Insert shape or feature>**.
3. Mounting: Pole with rectangular arm.
4. Luminaire-Mounting Height: 12'
5. Housings:
   a. Polyester powder coat finish.

B. Bollard:

1. Hess City Elements
2. Shape: Round
3. Diameter: 9.1 inches

C. Border:

1. MP Lighting, WE-EF
2. Shape: Round, Rectangle
3. Dimensions: 5 inches diameter.
4. Flush with grade.

D. Canopy:

1. Lithonia
2. Shape: Round
3. Dimensions: 6 inches in diameter

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.

C. 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. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch ((3.175 mm)) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. 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.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

    a. Color: per Architect.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected from manufacturer's standard catalog of colors.
    b. Color: Match Architect's sample of manufacturer's standard color.
    c. Color: As selected by Architect from manufacturer's full range.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

   a. IES LM-5.
   b. IES LM-50.
   c. IES LM-52.
   d. IES LM-64.
   e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. 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.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

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SECTION 270001 – GENERAL COMMUNICATION REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Communications Drawings and Specifications provide additional general construction and electrical requirements.

B. Any inconsistencies in the provided documentation (i.e., written specifications and/or drawings) shall be brought to the attention of the Owner or Owner Representative either with submitted bid or immediately upon discovery. A clarification or correction will be issued to address identified inconsistencies. The Contractor should not proceed with any element of the installation where instructions in one section conflict with those in another until clarification is provided by the Owner or Owner Representative. Disregard and failure to notify the Owner or Owner Representative of any project component that is inconsistently specified will not alleviate Contractor's responsibility for providing the more appropriate and/or expensive component or solution.

1.2 SUMMARY

A. The work covered by the communications specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, utilities and incidentals necessary for the complete installation of all communications work required in the contract documents and specified herein. The intent of the contract documents is to provide an installation complete in every respect.

B. The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of other trades.

C. The Contractor will be required and shall provide an allowance for obtaining permits for the project.

D. Section 271300 contains information necessary for the installation of Backbone Communications Cabling.

E. Section 270553 contains information regarding Communications Testing and Administration procedures.

F. Section 271100 contains information necessary to build out of Communications Equipment Rooms and Grounding.

1.3 DEFINITIONS AND ABBREVIATIONS

A. "Owner": Compton Community College District.

B. "Furnish" or "Provide": To supply, install and connect up complete and ready for safe and regular operation of particular work referred to unless specifically otherwise noted.

C. "Install": To erect, mount and connect complete with related accessories.

D. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

E. "Work": Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

F. "Equal": Equal in materials, weight, size, design and efficiency of specified product. The owner and it agents shall be the sole authority in determining what constitutes an equal substitution.

G. Server Room - The main room, which typically contains the Router, BDF and main Data Communications equipment.

H. TR: Telecommunications Room - Any additional room, which contains switches and hubs away from a central location to serve areas out of distance from the MTR.

I. IDF: Intermediate Distribution Frame – A termination frame for unshielded twisted pair cabling providing a connection field for horizontal wiring from the and feeder/riser cables extended to the BDF. Normally found in the Telecommunications Room.

J. BDF: Building Distribution Frame – a termination frame for OSP cable connecting a building to the campus as well as a termination frame for all building fiber and copper riser cable.

K. MPOE: Main Point of Entrance – Utility service entrance facility.

L. EMI: Electromagnetic interference.

M. IDC: Insulation displacement connector.

N. LAN: Local area network.

O. PVC: Polyvinyl chloride.

P. UTP: Unshielded Twisted Pair.

Q. RMU: Rack Mount Unit (1.75 inches)

R. UON: Unless Otherwise Noted.

S. Gb/s: Gigabits per second.

T. GbE: Gigabit Ethernet

U. UL: Underwriters Laboratory

1.4 DESCRIPTION OF PROJECT

A. General

1. In general, backbone cable will be installed, un-terminated outside of campus buildings other than the MIS building and the Instructional Building #1. Additionally, homerun ~~copper~~ and fiber cable is required for campus wide security devices.
2. In the campus-wide communications conduit distribution system, innerduct shall be installed for fiber optic cable.
3. OSP-rated ~~copper~~ and fiber optic backbone cable will be installed from the MIS building Main Telecommunications Room to ~~pull boxes outside of~~ Instructional Building #1. ~~In the terminating pull boxes, a minimum 300' coil of un-terminated cable shall left for future installation into building Service Entrance Rooms.~~
4. In the MIS building all fiber and copper cable will be terminated.
   ~~a. UTP 50-pair copper cable will terminate on backboard mounted protection panels.~~
   b. ~~24 strands Singlemode and~~ 24 strands Multimode fiber optic cable will terminate in existing rack-mount patch panels space.
   ~~c. 4 strands multi-mode fiber optic cable will terminate in a rack-mount patch panel for fire alarm (designed by others).~~
   ~~d. 2-strand singlemode fiber optic cable is required for security systems.~~
   e. Rack-mount fiber patch panels will be mounted in existing freestanding equipment racks.
5. In the Instructional Building #1 fiber and ~~copper cable will be terminated.~~
   ~~a. UTP 50-pair copper cable will terminate on a backboard mounted protection panel.~~
   b. ~~24 strands singlemode and 24~~ 12 strands multimode fiber optic cable will terminate in a rack-mount patch panel.
   ~~c. 4 strands multimode fiber optic cable will terminate in a rack-mount patch panel for fire alarm (designed by others).~~
   ~~d. 2-strand singlemode fiber optic cable is required for security systems.~~
   e. OSP-rated 4-pair copper cable is required for exterior emergency blue phones. These cables shall home run from the Instructional building #1 Telecommunications Room to each exterior emergency blue phones (designed by others).

B. Intermediate Distribution Frames (IDFs) – All new voice, data and video cabling will be installed and terminated within IDFs provided for the serving area. These IDFs shall be located within each building. Each IDF shall include General/Electrical Contractor-installed fire resistive plywood backboards, conduits/sleeves, air conditioning, and power and grounding. Equipment racks, overhead cable runway, wall-mounted 110 terminations, rack mounted patch panels and cable management hardware shall be installed by the Cabling Contractor.

C. Building Distribution Frames (BDFs) – All new voice, data and video cabling will be installed and terminated within BDFs provided for the serving area. These BDFs shall be located within building. BDF shall include General/Electrical Contractor-installed plywood backboards, conduits/sleeves, air conditioning, and power and grounding. Equipment racks, overhead

cable runway, wall-mounted 110 terminations, rack mounted patch panels and cable management hardware shall be installed by the Cabling Contractor.

D. Pathways – The Electrical Contractor shall provide all underground pathways. The Cabling Contractor shall install all cable support hardware in concealed building areas and cable runway within IDFs.

E. Horizontal Cabling – Typical horizontal cabling shall consist of Category 6, 4-pair, UTP, cables for voice, Category 6, 4-pair, UTP cables for data connections, Category 6, 4-pair UTP cables for exterior emergency telephones.

F. Backbone OSP and Riser Cabling – Backbone OSP Multi-pair UTP copper and fiber optic backbone cables are required between the MIS Building MDF/MPOE and Instructional building BDF. Riser cabling multi-pair UTP copper and fiber optic backbone cables are required between the IDF and BDF, Instructional Building #1.

G. Equipment Racks – Racks shall support the termination of all data, 4-pair, UTP station cabling terminated to Category 6, 48-port patch with horizontal wire managers. Racks shall also house rack-mounted UPS to support LAN active equipment provided and designed by District IT.

1.5 REFERENCES:

A. NEMA – National Electrical Manufacturer's Association

B. ANSI – American National Standards Institute

C. NEC – National Electric Code

D. RSEF – Relevant State Electrical and Fire Codes

E. IEEE – Institute of Electrical and Electronic Engineers

F. UL – Underwriters Laboratories, Inc.

G. ANSI/TIA – 568-C.0 Generic Telecommunications Cabling for Customer Premises

H. ANSI/TIA – 568-C.1 Commercial Building Telecommunications Cabling Standard

I. ANSI/TIA – 568-C.2 Balanced Twisted-Pair Telecommunication Cabling and Components Standard

J. ANSI/TIA – 568-C.3 Optical Fiber Cabling Components Standard

K. ANSI/TIA – 568-C.1 Commercial Building Telecommunications Cabling Standard

L. ANSI/TIA – 568-C.2-1 Transmission Performance Specifications for 4-pair 100 Ω Category 6 Cabling, provided the accuracy requirements for level III field testers; Category 6

M. ANSI/TIA – 569A Commercial Building Standard for Telecommunications Pathways and Spaces

N. ANSI/TIA – 606 The Administration Standard for the Telecommunications Pathways and Spaces

O. ANSI/TIA – 607 Commercial Building Grounding and Bonding Requirements for Telecommunications

P. ANSI/TIA – 598 Color Coding of Optical Fiber Cables

Q. BICSI – Building Industry Consulting Service International publications:

1. Telecommunications Distribution Methods Manual

2. LAN and Internetworking Design Manual

3. Telecommunications Cabling Installation Manual

4. Customer Owned Outside Plant Design Manual

5. Manufacturer's recommendations and installation guidelines

R. All cabling shall comply with all appropriate requirements of NEC Articles 770 and 800 and shall comply with the State Fire Codes as interpreted by the State Fire Marshall's Department.

S. All publications referred to in this document shall be the latest publicized edition.

1.6 EXTENT OF WORK

A. One contractor whose primary business is telecommunications shall perform all telecommunications work.

B. Extent of telecommunications work shall include: Horizontal and backbone voice, data and video cabling (e.g., UTP copper, fiber optic, coaxial) and MPOE/IDF build-out (e.g., equipment racks, cable runway, cable termination hardware, grounding, etc.)

1.7 QUALIFICATIONS

A. Contractor must be in the telecommunications business continually for at least 5 years.

B. Contractor must have installed at least 3 projects of similar scope and value in the last 2 years.

C. Cabling contractor must possess current certifications from the proposed manufacturer the contractor intends to install on this project.

D. All project managers, supervisors, lead technicians and technicians for the telecommunications contractor must each possess individual certifications for the products to offer a minimum of a 20 year manufacturer's warranty for the system the contractor intends to install on this project.

E. All personnel must be permanent employees of the telecommunications contractor.

F. The cabling contractor shall be a current member of Building Industry Consulting Service International (BICSI).

1.8 SUPERVISION

A. The project manager shall be the main point of contact for the project and the owner.

B. The Lead Technician shall be responsible for the direct supervision of not more than four (4) Technicians.

1.9 REGULATIONS AND CODE COMPLIANCE

A. All work shall comply with the applicable rules and regulations of the National Electrical Code, the National Electrical Safety Code, the National Electrical Fire Codes (published by National Fire Protection Association), Americans with Disabilities Act Regulations, the Local Authority Having Jurisdiction, the term and conditions of services of the communications utility, as well as any other authorities that may have lawful jurisdiction pertaining to the work specified.

B. The Cabling Contractor shall resolve any code violations or discrepancies discovered in the contract documents with the Owner prior to award of the contract.

C. Local codes may require the installation of additional fire stopping requirements. Contractor shall responsible of verification and compliance of all local codes. The owner shall not be responsible for additional costs not included in the contractor's original proposal.

D. The contractor shall secure all permits, approvals and pay all fees for all work installed.

1.10 SUBMITTALS

A. Bid Submittal

1. Cabling Contractor shall provide the following as part of the bid submittal.

    a. Pricing Schedule in the Appendices of the Project Manual.
    b. Proof in writing from the manufacturer stating that the Cabling Contractor is certified to install and extend the manufacturer's warranty for the proposed product solutions.
    c. Resume for the Cabling Contractor's Project Manager.
    d. Any exceptions, exclusions or clarifications to the bid.
    e. Catalog cut-sheets for any proposed substitutions.

B. Pre-Construction Submittal

1. Cabling Contractor shall submit the following after bid award and prior to construction.

    a. Complete bill of materials including product descriptions, quantities and part numbers.
    b. Catalog cut-sheets for all components including product features, ratings, and performance for each component specified. Products shall be clearly identified on cut-sheets.
    c. Samples of workstation outlets, jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.
    d. Samples of cable, termination hardware, and workstation outlet labeling.
    e. Project plan inclusive of schedule, staffing and quality assurance plan.
    f. Permit(s) for the work to be performed.

C. Construction and Post-Construction Submittal

1. Cabling Contractor shall submit the following during and following construction. The project shall not be considered complete and final payment will not be made until all submittals have been received and accepted by Owner.

    a. System warranty from the product manufacturer for installed structured cable systems as specified in Section 27 15 00.
    b. Test Results for all horizontal and backbone cabling.
    c. As-built drawings indicating all installed Telecommunications outlets. These drawings are required prior to and following punch list inspection by the Owner and/or their representative and must include all station labeling identification information.
    d. System labeling and cross-connect schedules (cable records) in electronic format.

D. Shop Drawings: May be required to accommodate actual building construction conditions that require modifications to equipment layouts as specified in the provided IDF drawings. When necessary, include dimensioned plan and elevation views of each individual component. Show equipment assemblies, method of field assembly, workspace requirements, and access for cable connections.

E. Product Certificates: For each type of cable, connector, and terminal equipment, signed by product manufacturer.

F. Quality-Control Plan and Test Reports.

G. Operation and Maintenance Data: For voice and data communication systems and/or cabling to include emergency, operation, and maintenance manuals.

1.11 QUALITY ASSURANCE

A. Installer Qualifications: System installer must have on staff a Registered Communication Distribution Designer (RCDD) certified by Building Industry Consulting Service International.

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. Contractor shall submit Quality Control Plan.

1.12 SUBSTITUTIONS

A. The bid shall include products per Part 2 of the specifications. The Owner may consider formal requests for substitution of products in place of those specified only if these are submitted with the bid for evaluation and in accordance with all conditions specified hereafter.

B. Requests for substitutions after award of contract shall be considered only in case of product unavailability. Manufacturer shall verify product unavailability in writing.

C. Submit separate requests for each substitution at time of bid, or at appropriate time thereafter in the event of non-availability of item included in bid. Support each request with:
   1. Complete data substantiating compliance of proposed substitution with requirements stated in this specification.
   2. Data relating to changes in construction schedule.
   3. Any effect of substitution on other work in this and other Elements, and any other related contracts, and changes required in other work or products.

D. Contractor shall be responsible (at no extra cost to the Owner) for any changes resulting from proposed substitutions, which affect work or other Sections or Elements.

E. Claims for additional costs caused by substitution, which may subsequently become apparent, shall be borne by the Contractor.

F. Substitutions will not be considered for acceptance when acceptance will require substantial revision of the design, unless contractor bears cost of redesign.

G. Where any redesign of electrical, mechanical, or other work is required due to substitution, arrangement or equipment layout other than herein specified or shown:
   1. Arrange for required redesign by Project Architect.
   2. Pay all costs for such redesign.

H. Substitute products shall not be ordered or installed without prior written approval/acceptance by the Owner.

I. The Owner will have sole discretion to determine acceptability of proposed substitutions and reserves the right to reject any such substitution.

J. Approval of substitutions shall not relieve Contractor from full compliance with requirements of these specifications.

1.13 COORDINATION

A. Coordinate layout and installation of voice, data and video communication cabling with Telecommunications, LAN and audio-visual equipment suppliers.
   1. Meet jointly with Security, Audio-Visual and LAN installation contractors, equipment suppliers, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute to other participants.
   3. Adjust arrangements and locations of equipment racks, cross-connect and patch panels in MPOEs and IDFs to accommodate and optimize arrangement and space requirements of voice, data, security and video equipment.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cable Hangers and Supports

B. Cable Tray

C. Velcro Cable Ties

D. Measuring Strings or Pull Lines

E. Innerduct

F. General

PART 2 PRODUCTS

2.01 CABLE HANGERS AND SUPPORTS

A. Each support shall have a smooth, wide load-bearing surface to support its full capacity of cables without causing any crimping of the cables at the bottom of the support.

B. J-Hooks shall be capable of assembly onto multiple hook hanger straps.

C. H-Hook and multiple J-hook assemblies shall be capable of attachment to concrete, steel beam flanges, C and Z purlin clips and hanger wire or rod.

D. Cable hooks shall have a flat bottom and provide a minimum of 1-5/8" cable bearing surface.

E. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.

F. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.

G. Cable hooks shall have a stainless steel cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.

H. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.

I. Factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.

J. Cable hooks shall have the manufacturers name and part number stamped in the part itself for identification.

K. Cable hooks shall be listed and labeled by Underwriters Laboratories (UL) and by UL to Canadian standards (cUL) as required.

L. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.

M. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.

N. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

O. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of 3 where extra strength is required.

P. Submit product data on cable hook devices, including attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

Q. Manufacturer
1. Erico/Caddy
2. Or equal

2.02 CABLE TRAY

A. Cable tray shall be manufactured form high strength 5-mm or higher gauge steel wire. Straight section longitudinal wire sections shall have a continuous T-weld top edge-wire safety design.

B. Cable tray section steel wires shall be formed into a two inch (2") by four inch (4") wire mesh pattern welded together.

C. Cable tray sections shall be ten feet (10') in length, eighteen inches (18") wide by a minimum of four inches (4") deep unless otherwise noted in the drawings.

D. Cable tray finish shall be pre-galvanized steel or white powder coated finish.

E. Cable tray fittings shall be field formed from straight sections according to manufacturer's instructions to form 45 degree elbows, 90 degree bends, elevation drops or rises, tees, crosses, and reducers.

F. Cable tray sections and splicing assemblies shall be UL Classified as an Equipment Ground Conductor.

G. Each end of cable tray shall be equipped with a finished lip and drop off to reduce damage to cables.

H. All sections of wire basket shall be equipped with a polymer insert which also serves as a tray liner. Insert must be as wide as wire basket, coordinate tray liner color with architect.

I. Manufacturer:
   1. Hoffman part# QTP4X18 (18" W x 4"D, Color to be coordinated with Architect)

2.03 VELCRO TIE WRAPS

A. Velcro cable ties shall be .5" in width.

B. Velcro cable ties shall be black in color.

C. Manufacturer
   1. Panduit
   2. Or equal

2.04 MEASURING STRINGS OR PULL LINES

A. Shall be used to fish and measure conduit runs in one operation.

B. Permanently printed measurements every foot from zero to 3000' (914 m).

C. Made of strong, waterproof polyester.

D. Capacity 130 lbs. (578 N) average breaking strength

E. Manufacturer
   1. Greenlee
   2. Or equal

2.05 INNERDUCT

A. The use of innerduct is required for the placement of all fiber optic cabling. The innerduct shall be at minimum meet the Underwriters Laboratory (UL) specifications 2024.

B. Three 3-cell mesh type innerducts shall be installed in underground pathways shall be rated for underground conditions.

C. Corrugated innerduct shall be installed for intra- building shall be plenum-rated.

D. Corrugated innerduct shall be one-inch (25.4 mm) inside diameter.

E. All corrugated innerduct shall be orange in color.

F. See Section 27 13 00 for additional innerduct requirements.

G. Manufacturer
   1. MaxCell

2. Carlon
3. Endot
4. Or equal

PART 3 EXECUTION

3.01 CABLE HANGERS AND SUPPORTS

A. Attach J-Hooks to flat, metallic support straps manufactured for that purpose with 3/16" to 1/4"x3/4" machine screw or bolt and nut. Do not exceed 4' center between supports.

B. Multiple hook assemblies may be used where necessary to accommodate cable bundles where maximum fill is exceeded.

C. Attach J-Hook assemblies along and perpendicular to building's structural lines, preferably above hallways entering rooms served above doors.

D. Establish routing in coordination with all other trades. Minimize elevation changes and keep the routing above all conduit and duct work where possible.

E. J-Hooks shall not be attached to support wire for ceiling tile grid, support assemblies for electrical conduits or the conduits themselves, or support assemblies for the fire protection systems.

F. J-Hooks style support brackets shall be used as cable hangers for applications where cable tray is not installed.

G. Follow manufacturer's recommendations for allowable fill capacity for each size of cable hook.

H. Installation and configuration shall conform to the requirements of the ANSI/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.

3.02 CABLE TRAY

A. The cable tray shall be supported no less than every five feet (5') or as indicated by structural engineer of record. Support attachments shall be made only to the building structure.

B. Cable tray supports, brackets, splicing accessories, hangers, vertical downs, inserts, fasteners and divider strips shall be provided by the same manufacturer of the cable tray sections for a complete solution

C. Furnish and install all components of the cable tray system (supports, splice accessories, fasteners, brackets, hangers, vertical downs, inserts and divider strips) from a single manufacturer

1. All pathways shall avoid electromagnetic interference (EMI). Cable that is distributed in partially-enclosed metallic pathways shall be routed with the following minimum clearances:

a. Four (4) feet from motors or transformers.

b. One (1) foot from conduit and cables used for electrical power and distribution

c. Five (5) inches from fluorescent lighting

2. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables and conduits.

3. Cable trays shall be installed in accordance with NEMA VE 2.

4. The Contractor will be responsible for placement of the cable tray in concert with other trades, allowing sufficient room for the cable installers to gain access to all portions of the tray system. Cable tray location shall be coordinated with open ceiling areas, access panel locations and feeder conduit positions to provide an accessible cable pathway throughout the facility.

5. All metallic cable trays must be grounded and may be used as an equipment grounding conductor must be clearly marked. Use #6 AWG conductors to connect portions of cable tray in order to maintain continuity throughout the total length of the tray.

6. Trays shall be bonded end-to-end.

7. When cable trays enter distribution rooms, they should enter six (6") inches into the room, then utilize a drop out to protect station cables from potential damage from the end of the tray.

8. Cable trays shall be placed a minimum of six (6") inches from any overhead light fixture and twelve (12") inches from any electrical ballast. A minimum of eight (8") inches of clearance above the tray shall be maintained at all times. All bends and T-joints in the tray shall be fully accessible from above (within 1 foot). It is recommended that cable trays shall be mounted no higher than twelve (12') feet above the finished floor and shall not extend more than eight (8') feet over a fixed ceiling area.

9. A separate conduit sleeve or sleeve system (minimum of two inches) must be provided as a pathway through any wall or over any obstruction (such as a rated hallway) from the cable tray into any room having a communications outlet

10. The Contractor shall fire stop around the cable tray and, after installation of the cables, within the tray using removable pillow-style products and/or other pre-approved fire stop products following manufacturers' guidelines. Sound deadening material shall be provided and installed after installation of cable.

11. In rooms without a drop ceiling (open to the structure), the cable tray shall be mounted as high as possible to provide the greatest clearance above the finished floor

3.03 TIE WRAPS

A. Tie wrap all cable bundles according to provisions of ANSI/TIA 569A, portions of this section and all amendments to these documents issued to date.

B. Velcro tie wraps shall be used to attach all cables to J-Hooks and shall be used to dress out cables to form neat, smooth bundles along pathways.

C. Velcro, TM-Type tie wraps shall be used for Category 6 cables.

D. All tie wraps shall be installed at slightly irregular intervals to prevent harmonic interference and, as required at specified locations to obtain a neat result.

3.04 MEASURING TAPES AND PULL LINES

A. Leave measuring tape suitable for use as a pull line after installing the last cable or innerduct in any conduit other than stubbed-up conduit for wall outlets.

B. Measuring tapes shall be installed into concealed conduit runs.

C. Measuring tape shall be installed in one duct of multiple conduit runs that have common origins and destinations in addition to being concealed.

D. Measuring tapes shall not be used as pull lines.

E. All pull lines shall be secured at each end to prevent accidental removal.

F. Pull lines shall be left in all conduits and along all pathways after cabling has been installed to facilitate future additions to the infrastructure.

G. Secure all trailing pull lines top prevent accidental removal.

3.05 INNERDUCT

A. Install fiber optic cabling indicated in Section 271300.

B. Mesh-type MaxCell multi-cell innerduct (three 3-cell units) shall be installed in 4" conduit to support (9) fiber optic cables.

C. 1" corrugated innerduct shall be installed in 4" conduit that shares UTP copper cable. This condition will occur in conduit pathways that route to and enter Telecommunications Rooms.

3.06 GENERAL

A. All horizontal cable tray and under floor pathways shall be installed by the Electrical Contractor.

B. Cabling Contractor to coordinate installation of all cable pathways.

C. All horizontal pathways shall be bonded and grounded per the NEC Article 250.

D. In all cases, horizontal pathways shall be sized for a minimum of 50% future growth

E. Pathways must not exceed a maximum of 40% fill at any time during this installation.

F. Cabling shall exit Telecommunications Rooms through a riser and horizontal conduit sleeves provided by the Electrical Contractor.

G. All other miscellaneous sleeves required for Telecommunications Cabling shall be provided by the Cabling contractor.

H. Cabling Contractor shall fire stop all penetrations required by local building authority. Coordinate fire stopping requirements with General Contractor.

END OF SECTION

SECTION 270553 – COMMUNICATIONS TESTING AND ADMINISTRATION

PART 1 GENERAL

1.1 IDENTIFICATION AND LABELING

A. The contractor shall label the cabling system as indicated on the drawings and in accordance with ANSI/TIA 606.

B. All label printing will be machine generated. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

C. All labeling schemes must be pre-approved by the Owner or the Owners Representative prior to installation.

1.2 TESTING AND ACCEPTANCE

A. General
1. All cables and termination hardware shall be 100 percent tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 and associated addendums. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100 percent useable conductors in all cables installed.
2. All cables shall be tested in accordance with this document, the ANSI/TIA standards, manufacturer specifications and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

B. Copper Channel Testing
1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level IIe test unit for category 6-performance compliance, respectively.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number.

Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
4. Category 6 Performance: Follow the standards requirements established in ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 and associated addendums.

C. Copper Backbone Testing
1. All UTP copper riser/backbone cables shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Backbone cabling shall be tested using a 25-pair test unit.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
3. Length - Each installed cable shall be tested for installed length using a TDR type device. The cables shall be tested from block to block, block to outlet as appropriate. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

D. Fiber Testing
1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly defined. Testing shall consist of an end-to-end power meter test performed per ANSI/TIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers. These tests also include continuity checking of each fiber.
2. Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for singlemode) in one direction utilizing an OTDR test unit.
3. Test set-up and performance shall be conducted in accordance with ANSI/TIA-526-14 Standard, Method B.
4. Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. Only basic link test is required. The contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA Standard.

5. Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

1.3 SYSTEM DOCUMENTATION

A. Upon completion of the installation, the contractor shall provide 3 full documentation sets to the Owner for approval. Documentation shall include the items detailed in the sub-sections below.

B. Document sets shall include CD(s) with product cut-sheets, as-built drawings, test results, cable records, etc.

C. Documentation shall be submitted within 10 working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the Owner, the contractor shall provide copies of the original test results.

D. The Owner may request that a 10 percent random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the contractor, additional testing can be requested to the extent determined necessary by the Owner, including a 100 percent re-test. This re-test shall be at no additional cost to the Owner.

E. Contractor shall provide matrix "Cable Records" to Owner including outlet number, apartment number, IDF, backbone cable number(s) with pairs cross-connected. In addition to required number of Document sets, Contractor shall provide a bound set of cable records with grommet and chain attached to MPOE backboard adjacent to protection panels. This documentation shall be submitted within 10 working days prior to the completion of the project.

1.4 TEST RESULTS

A. Test documentation shall be provided on compact disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). This compact disk shall include any and all software required to view test results. Test results file formats shall be in the original format extracted from the test unit. A file exported to an editable file format is not an acceptable alternate. The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment

used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

B. The field test equipment shall meet the requirements of ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 including applicable TSB's and amendments. The appropriate level IIe tester shall be used to verify Category 6 cabling systems.

C. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the contractor may furnish this information in electronic form (compact disk). This compact disk shall contain the electronic equivalent of the test results as defined by the bid specification and be of a format readable from Microsoft Word 2000.

D. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

1.5 AS-BUILT DRAWINGS

A. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD 2000) formats on which as-built construction information can be added. These documents will be modified accordingly by the contractor to denote as-built information as defined above and returned to the Owner.

1.6 WARRANTY

A. An Extended Product Warranty that shall cover all labor and materials. Warranty shall be provided from the Product Manufacturer, which warrants functionality of all components used in the system for no less than 20 years from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and backbone copper UTP, and the backbone fiber optic portions of the cabling system. The Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2. These applications included, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, and 155 Mbps ATM. The Contractor shall be certified to install the product to qualify for the Manufacturer Extended Product Warranty. As part of the proposal, contractor shall submit documentation explaining how the proposed manufacturer will support future applications such as gigabit over category 6.

1.7 FINAL ACCEPTANCE AND SYSTEM CERTIFICATION

A. Successful completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two-week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate from the Manufacturer registering the installation. Owner will appoint an

authorized agent that will sign a formal acceptance document upon completion of all of the above.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 271100 – COMMUNICATIONS EQUIPMENT ROOMS

PART 1 GENERAL

1.1 Build-out (installation of racks, cabinets, cable runway, cable management, etc.) of Instructional Building #1, Building-Entry, BDF and IDF shall be provided by the Cabling Contractor.

1.2 Backboards, conduits, sleeves, power and grounding in the Instructional Building #1, Building-Entry, BDF and IDF shall be provided by the General and Electrical Contractor.

1.3 SECTION INCLUDES

A. Installation of freestanding and wall-mount Equipment Racks

B. Installation of Cable Management – Vertical and Horizontal

C. Installation of wall-mounted 110 Termination Blocks

D. Installation of Backbone UTP Protection Panels and Units

E. Installation of Category 6 UTP Patch Panels

F. Installation of Category 6 UTP Patch Cables

G. Installation of Fiber Optic Patch Panels

H. Installation of Fiber Optic Patch Cables

I. Installation of Grounding

J. Installation of Overhead Cable Runway

K. Installation of Voice Cross-connects

1.4 SYSTEM REQUIREMENTS

A. General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

B. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in backbone cables, and provide spare positions in cross-connects and terminal strips to accommodate 20 percent future increase in active services.

1.5 MOUNTING ELEMENTS

A. Pathways: Comply with Section 27 05 28 Pathways for Communications Systems.

B. Backboards: 0.75-inch, ACX interior-grade, fire-retardant-treated plywood painted with 2 coats of fire-retardant white paint.

C. All free standing racks and cabinets shall be seismically securely to Zone-4 requirements to the concrete floor using minimum .25-inch hardware or as required by local codes.

D. Racks shall be placed with a minimum of 36 inches clearance from the walls on three sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at one end of the row.

E. All racks and cable runways shall be grounded to the telecommunications grounding bus bar in accordance with Grounding System requirements.

F. Rack-mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

G. Wall-mounted termination block fields shall be mounted on 4 feet by 8 feet by 0.75-inch ACX void free plywood. The plywood shall be mounted vertically 12 inches above the finished floor. The plywood shall be painted with 2 coats of white fire retardant paint. Wall-mount termination block fields shall be installed with the lowest edge of the mounting frame 18 inches from the finished floor.

PART 2 PRODUCTS

2.1 2-POST RACKS

A. 2-post racks shall have power distribution and cable management for server and networking applications in IT environments.

B. ICT Contractor shall provide, install, ground and seismic brace 2-post racks in the BDF and IDF's.

C. The unit shall conform to TIA-610 Standard for, Racks, Panels and Associated Equipment and accommodate industry standard 19" rack mount equipment.

D. The unit shall be designed with four (2) vertical posts to allow rack mount equipment installation utilizing four (2) vertical mounting rails.

E. The unit shall provide 45U of equipment vertical mounting space (1U=1.75" or 44.45mm).

F. The vertical mounting rails shall be adjustable to allow different mounting depths.

G. The unit shall include at least 50 sets of mounting screws, caged nuts, bolts and cup

washers, and caged nut installation tool for the mounting of equipment inside the unit.

H. All weight bearing components shall be constructed from steel no less than 0.9mm (20 gauge).

I. All metal parts shall be painted using a powder coat paint process.

J. Racks shall be black over a brushed aluminum finish.

K. Plastic materials shall comply with Underwriters Laboratory Specification 94 with V-1 rating (UL94 V-1) or better.

L. Provisions shall be provided for all rack-mounted equipment to be earthed or grounded directly to the frame.

M. Unit shall include a grounding kit containing terminated green/yellow jumper wires and associated hardware.

N. Units shall be equipped with vertical and horizontal wire management.

O. Racks will require (2) PDU brackets per cabinet.

P. Freestanding modular aluminum units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

Q. Material:

1. Approximate Module Dimensions: 84 inches high by 19 inches wide by 3 inches channel depth.
2. Racks shall be all high strength, lightweight 6061-T6 aluminum extrusion construction.
3. Racks shall be equipped with two top angles or top bars and heavy-duty assembly hardware.
4. Racks shall have EIA hole pattern on front and rear.
5. Racks shall assemble as 19 inches with no additional hardware.
6. Racks shall have EIA Channel: 3 inches x 1.265 inch x 0.25 inch thick flange.
7. Racks shall have Base Angles: 3.5 inches by 6 inches by 0.125 inch thick (pair).
8. Racks shall have Top Angles: 1.5 inch by 1.5 inch by 0.25 inch (pair).
9. Racks shall have Top Bars: 1.5 inch by 0.25 inch (pair).
10. Racks shall have a weight capacity of 1000 lbs. Weight must be evenly distributed.
11. Racks shall be black over a brushed aluminum finish.
12. Racks shall provide floor and ceiling access for cable management and distribution.
13. Racks shall provide pre-drilled base for floor attachment of rack.
14. Racks shall be seismic/earthquake braced.
15. Racks shall be black in color.
16. Contractor shall provide cable runway elevation kit.

R. Manufacturer:
   1. Chatsworth Products, Inc. p/n# 55053-703
   2. Or Equal

2.3 HEAVY DUTY EQUIPMENT SHELF FOR 3" CHANNEL

A. Shelves, black in color, shall be installed at the bottom of freestanding racks. These 20" deep, 200 lb. rated shelves are needed to support UPS units.

B. Manufacturer:
   1. Chatsworth Products, Inc.
   2. Or Equal

2.4 CABLE RUNWAY (LADDER RACKING)

A. Cable runway support shall be installed in Telecommunications Rooms as shown on the drawings. Size: 18 inches wide.

B. Classified by Underwriters Laboratories (UL) as suitable for equipment grounding.

C. Cable Runway shall be used for voice and, or data and video communications cabling only. No electrical wiring shall be placed on runway with voice and data cabling.

D. Wall angle supports shall be steel angles. Ends to be smooth without hooks or projections. Brackets shall be able to support an end load of 600 lb. with a safety factor of 1.65.

E. Elbows, Tee's, 90degree bends and crosses: All horizontal and vertical 90 degree elbows, tee's, 90 degree bends and crosses shall be made with right angle couplings which clamp to the runway without the need for drilling or cutting.

F. At all horizontal 90-degree bends, tees, and crosses, provide adjustable junction splice kits for large radius cable bends.

G. Where cables transition from runway to termination equipment or racks, provide cable radius managing waterfall attachments.

H. Seismically supported by end wall supports, angular wall support and communications equipment racks.

I. Protective End Caps on all exposed cable runway ends.

J. Black baked enamel finish.

K. Manufacturer:

   1. Chatsworth Products, Inc.

2. Or Equal

2.5 WIRE MANAGEMENT

A. Materials

B. All equipment racks shall be equipped with vertical and horizontal wire management organizers. All horizontal wire managers shall be heavy duty painted black metal units designed specifically to connect to equipment frames. All vertical wire managers shall be aluminum with a black finish. All wire managers shall be secured to the frames and shall provide a clear and unobstructed pathway in which to route the cables.
   1. The Vertical cable manager shall be constructed of metal backbone with pass through holes and plastic cable management fingers.
   2. The cable management fingers shall be molded out of plastic and incorporate bend radius control throughout the entire length.
   3. The panel shall have a metal door that will be capable of opening to the left or right when mounted.
   4. The panel shall be capable of mounting to EIA standard channel, deep channel and telco style racks.
   5. Vertical wire managers shall be double-sided 4.4 inches wide by 7 feet tall. Vertical wire mangers shall have evenly 1 RMU spaced wire rings designed to maintain jumper, patch, or cross-connect wire in place.
   6. Vertical wire managers shall be designed to extend past the frame to allow placement of equipment in any position within the rack. When mounted between equipment frames, they shall be designed to direct cables into either frame and shall be securely mounted to both units.
   7. Vertical wire managers shall be equipped with rigid aluminum Switch Gate Door/Cover with reversible access that conceals cable.
   8. Vertical wire managers shall be provided black in color.

C. Horizontal Wire Managers (Equipment Racks)
   1. The in-frame horizontal managers shall be 2 RMU in height and shall extend from side rail to side rail.
   2. Double-sided design and pass-through slots for easy organization of front and rear cables.
   3. Include cable guide fingers at 1.75” intervals for proper cable bend radius and organization of patch cords.
   4. Flanged pass-through slots to route cables to the back.
   5. Include Snap-on, hinged door/cover.
   6. Black in color.

D. Horizontal Wire Managers (Wall-Mount Brackets)
   1. Shall be 2 RMU in height and shall extend from side rail to side rail.
   2. Single-sided design.
   3. Include cable guide fingers at 1.75” intervals for proper cable bend radius and organization of patch cords.
   4. Include Snap-on, hinged door/cover.

5. Black in color.

E. Cable Management for Wall Racks
1. Cable management rings shall be installed on wall-mount racks.
2. Black polymer-blend material that is UL Rated for use in plenum spaces.
3. Flexible material holds bundles secure while also allowing easy entrance of additional cables.
4. Internal diameter 3".
5. Kit includes 6 rings and mounting hardware

F. Manufacturer:
1. Chatsworth Products, Inc.
2. Or Equal

2.6 PLYWOOD BACKBOARD

A. The General Contractor shall provide and install all MPOE and Telecommunications Room backboards.

B. Provide .75-inch (19.05 mm) ACX void-free, fire rated plywood as noted on construction documents.

C. All walls noted on construction documents must be covered with .75 inch (19.05 mm) thick by 8 feet-0 inches (2438.4 mm) high ACX plywood, painted with two coats of insulating fire-retardant white paint.

D. Backboards shall be mounted vertically, starting 6 inches (152.4 mm) above the finished floor, and secured to the walls.

E. All backboards are to be constructed of 4 feet (1219.2 mm) by 8 feet (2438.4 mm) plywood.

F. All plywood panels must be mounted in contact with one another, leaving no gaps between sheets.

G. All exposed edges must be chamfered. Screws, bolts, washers and/or nuts are to be counter sunk to be flush with the surface of the plywood.

~~2.7 WALL-MOUNTED 110 WIRING BLOCKS~~

~~A. Application: Shall be used to terminate voice station and voice backbone cable.~~

~~B. Compliance: Comply with ANSI/TIA-568-B.1 and ANSI/TIA -568-B.2 Category 5 specifications requirements and associated addendums, ANSI/TIA-606A labeling standards.~~

~~C. All voice station cable terminations shall be made on wall-mounted 110 wiring blocks with C4 connectors.~~

D. Intra-building voice backbone cable terminations shall be made on wall-mounted 110 wiring blocks with C5 connectors.

E. All blocks shall be UL listed.

F. Characteristics: The 110 Wiring Blocks shall:
1. Facilitate cross-connection and/or interconnection using either cross-connect wire or patch cords.
2. Be manufactured using fire retardant molded plastic with the base consisting of horizontal index strips for termination up to 25-pairs of conductors.
3. Support termination of 22, 24 and 26 AWG solid conductor.
4. Be available in 50-, 100- and 300-pair sizes. Sizes specified within drawings contain access opening for rear to front cable routing to the point of termination.
5. Have termination strips on the base to be notched and divided into 4-pair and/or 5-pair increments.
6. Have clear label holders with the appropriate colored inserts available for the wiring blocks. The insert labels provided with the basis of circuit size (1-, 3-, 4- or 5-pair) and shall not interfere with running, tracing or removing jumper wire/patch cords.
7. Have bases available in 19-inch (482.6 mm) panels and high-density frame configurations for rack or wall mounting with cable management hardware.
8. Have connecting blocks used for either the termination of cross-connect jumper wire or patch cords. The connecting blocks shall be available in 2-, 3, 4- and 5-pair sizes. All connecting blocks shall have color-coded tip and ring designation markers and be single piece construction.
9. Be capable of accommodating a minimum of 200 repeated insertions without resulting in permanent deformation.

G. Manufacturer:
1. AMP
2. Panduit
3. Leviton
4. Or Equal

2.8 PROTECTOR PANELS AND UNITS

A. Application: Inter-building and entrance cable protection will be vendor's protector panel equipped with protector units. Protector panels shall meet NEC Article 800, Part C requirements. Protector panels shall provide protection for communications equipment and circuits exposed to voltage surges and sneak currents. The protector panel shall be equipped with 110-style terminations in and out.

B. Protector units shall be UL 497 listed for primary circuit protection. Protector units shall provide protection for communications equipment and circuits exposed to voltage surges and sneak currents. The protector units shall be equipped with solid state surge arrestors for sneak current protection.

~~C. Manufacturer:~~

~~1. Circa~~
~~2. Marconi~~
~~3. Or Equal~~

2.9 UTP CATEGORY 6 PATCH PANELS

A. Application: Use to terminate all horizontal data station cabling.

B. Compliance: Listed as complying with ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 Category 6 specifications requirements and associated addendums, ANSI/TIA- 606 labeling standards.

C. Characteristics: Patch panels shall:
1. Be available in 48-port high-density configurations.
2. Modular Patch Panels shall be of a metal design with snap in four position and six position molded faceplate frames.
3. Patch panels shall be available with labels.
4. Patch panel modular jack assemblies shall be color coded as specified within Section 17140-3.3.
5. Be mountable in freestanding equipment rack.
6. Be labeled above the RJ45 module.
7. Be 2 RMU in height and shall extend from side rail to side rail.

D. Manufacturer:
1. AMP
2. Panduit
3. Ortronics
4. Or Equal

2.10 UTP CATEGORY 6 PATCH CABLES

A. UTP Patch Cables. Patch cables for unshielded twisted pair cable shall be Category 6 rated and shall be equipped with factory-attached connectors to interconnect equipment mounted on the racks of the distribution frame and to connect computer stations to outlet locations.

B. Patch cords may also be used for patching applications; not to exceed 20 feet. Quantity required for 100% port population at both ends with 10% spare.

C. Contractor shall provide:

1. BDF/IDF Patch Cords – 6-inches in length, Category 6 and colored according to the following:
   a. Green for instructional network
   b. Blue for non-instructional network
   c. White for everything else

d. Number of each color to be confirmed with Owner or District Representative.

2. Workstations – 10 feet in length, Category 6, black in color.

D. Manufacturer:
1. AMP
2. Panduit
3. Ortronics
4. Or Equal

2.12 FIBER PATCH PANELS

A. Manufacturer: Ortronics or District approved equal.

B. Provide panel for maintenance and cross connecting of fiber optic cables.

C. Panel shall be constructed of 0.125-inch minimum aluminum and shall have connectors which interface the inside plant fiber optic jumper cable with the outside plant fiber optic cable.

D. Panels shall be equipped with engraved laminated plastic nameplates above each connector.

E. Rack-mounted fiber patch panels shall be equipped to terminate or splice the incoming inter-building fiber and any required backbone or interconnect cables.

F. Each cable must be properly dressed.

G. These units will terminate the fiber optic cables, provide a place for jumper cables and will provide room to terminate additional optics.

H. Panel shall provide capacity for minimum of 12 fiber optic strands. Larger capacity patch panels shall be determined at site walk.

I. Panel shall be 100% populated with type LC couplers and adapter plates.

J. All connectors and couplers will be type LC.

K. The fiber optic patch panel connections shall provide 0.4 dB or less insertion loss.

2.13 FIBER OPTIC PATCH CABLES

A. Manufacturer: Superior Essex, or District approved equal.

B. Fiber Optic Patch Cables shall be Multimode or Single Mode patch cords pre-made to connect fiber optic equipment with fiber optic cross connects, interconnects and outlets.

C. The patch cords (jumpers) shall be impact-resistant, duplex fiber cables with LC connectors, of the same performance characteristics as the Single Mode fiber backbone being connected.

D. These fiber optic patch panel connections shall provide 0.4 dB or less insertion loss and provide connection between the Active LAN devices and the Fiber Optic patch panel. Quantities for 100% fiber strand population at both ends plus 10% Spares.

E. Contractor shall provide:

1. IDF Patch Cords – 1 Meter in length, LC connectorized, Multimode ~~and Single Mode,~~ duplex, fiber optic patch cord.
2. MDF/BDF Patch Cords – 3 Meter in length, LC connectorized, Multimode ~~and Single Mode~~ duplex, fiber optic patch cord.

2.11 GROUNDING SYSTEM

A. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA- 607 Telecommunications Bonding and Grounding Standard.

B. The TBB shall adhere to the recommendations of the ANSI/TIA-607 standard, and shall be installed in accordance with industry best practice.

C. The General Contractor shall be responsible for having a licensed Electrical Contractor provide and install the TBB to the building service entrance ground.

D. The main entrance facility shall be equipped with a telecommunications main grounding bus bar (TMGB). The Site MPOE and each Telecommunications Room shall be provided with a telecommunications ground bus bar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached. Installation of building ground systems shall be the responsibility of the Electrical Contractor.

E. All racks, cable runway, metallic backboards, cable sheaths, etc. entering or residing in the MPOEs and building Telecommunications Rooms shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors. Bonding of cable sheaths and equipment within these rooms shall be the responsibility of the cabling Contractor.

F. All wires used for telecommunications grounding purposes shall be identified with a green

insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.

G. Manufacturer:
   1. Chatsworth Products, Inc.
   2. Or Equal

PART 3 EXECUTION

3.1 EQUIPMENT RACKS, SHELVES AND SERVER RACKS

A. Coordinate all work for final mounting locations of all equipment.

B. Provide and install all cable runways as defined on Telecommunications drawings and specifications.

C. Provide and install ¾" fire rated plywood backboards within Telecommunications Room as identified within Telecommunications Drawings and specifications.

D. Provide and install all equipment racks and cabinets.

E. Provide seismic anchoring of all racks and cabinets to meet Zone-4 compliance.

F. Provide and install all vertical and horizontal wire managers.

G. Provide and install required rack-mounted patch panels and wall-mounted 110 termination hardware.

3.2 CABLE MANAGEMENT

A. Provide and install two vertical wire management panels to each 19" x 7' equipment rack installed.

B. Provide and install one (1) 2U horizontal wire management panel for each UTP patch panel and fiber optic enclosure installed.

3.3 UTP PATCH PANELS

A. Provide and install 48-port, Category 6 patch panels within Telecommunications Rooms.

B. Contractor shall verify and provide exact quantities required.

3.4 FIBER OPTIC PATCH PANELS

A. Provide and install fiber optic patch panels within the building MPOE and building Telecommunications Rooms.

B. Provide and install necessary adapter and blank panels.

~~3.5 VOICE TERMINATION BLOCKS~~

~~A. Provide and install 110 type termination blocks with wiring troughs within Telecommunications Rooms.~~

~~B. Provide lightning protection termination terminals for all outside plant/underground cable installed.~~

~~C. Contractor shall verify and provide quantities required.~~

3.6 CROSS CONNECTS

A. Provide all cross-connect (1 pr. hook-up) wire required in the Instructional Building #1 MPOE and TRs.

B. Backbone cable to backbone cable, cross-connect all pairs.

C. Backbone to voice station cable and emergency telephone cable, cross-connect one (1) pair per station.

3.7 CABLE RUNWAY (LADDER RACKING)

A. Provide and install all ladder rack as defined within the Telecommunications Drawings.

B. Provide and install all required mounting/supporting hardware required.

3.8 TIE WRAPS

A. Provide and install Velcro cable ties to manage and secure all installed cables within MPOEs and Telecommunications Rooms.

3.9 GROUNDING

A. The Electrical Contractor shall provide and install the Telecommunications grounding system to each MPOEs and Telecommunications Rooms.

B. Provide and install grounding bus bars within MPOEs and Telecommunications Rooms as identified on the Telecommunications Drawings.

C. The Cabling Contractor shall provide and install grounding within BDF and IDF Rooms as follows.
   1. Inter-building cable sheaths shall individually bonded to the TGB.
   2. Each rack shall be individually bonded to the TGB.
   3. Each cable runway section shall be bonded together with ground straps.
   4. Cable runway strapped system shall be bonded to the TGB.
   5. Ground all equipment within Telecommunications Room with a minimum #6 AWG conductor.

END OF SECTION

SECTION 271300 – COMMUNICATIONS BACKBONE CABLING

PART 1 GENERAL

1.1 WORK INCLUDED

A. Multi-mode Fiber Optic Backbone Cable

B. Fiber Optic Patch Panels

C. Copper UTP Backbone Cables

1.2 SUMITTALS

A. Refer to Section 270001 for submittal procedures.

B. Provide submittals for materials required by this section.

C. Submittals shall consist of catalogue cut sheets and/or engineering specification sheets provided by the manufacturer.

PART 2 PRODUCTS

2.1 FIBER BACKBONE CABLE (INTER-BUILDING)

A. Application: Use for inter-building data backbone cabling.

B. Compliance: Must comply with ANSI/TIA-568-B standard specifications.

C. Characteristics: Cable:
1. 24-strand multimode ~~and 24-strand singlemode~~
2. Suitable for outdoor applications
3. Water exclusion gel-filled
4. Dielectric strength member
5. Loose tube construction
6. Maximum short term pulling tensile of 600 lbs. and long term pulling tension of 200 lbs.
7. Equip with breakout, furcation or blocking kit to dress the end of the cable and eliminate the flow of fill compound.

D. Characteristics Multimode fiber:
1. Will support 10 Gps for a minimum distance of 550 meters.
2. 50/125µm (core/cladding) dual window (850 and 1300 nanometers).
3. Maximum attenuation: 3.0 dB/km @ 850 nm and 1.0 dB/km @ 1300 nm.
4. Minimum bandwidth: 3000 MHz/km @ 850 nm and 500 MHz/km @ 1300 nm.
5. 275 numerical aperture ± 0.015

~~E. Characteristics Singlemode fiber:~~
~~1. Core Diameter: 8.2 um~~
~~2. Numerical Aperture: 0.14~~
~~3. Maximum attenuation: 0.32 dB/km @ 1310 nm and 0.18 dB/km @ 1550 nm.~~
~~4. Effective Group Index of Refraction: 1310 nm: 1.4676; 1550 nm: 1.46.82~~
~~5. Rayleigh Backscatter Coeffieient (for 1 ns Pulse Width): 1310: -77 db; 1550 nm: -82 db~~

F. Cable sizes defined in Contract Documents.
1. Refer to Telecommunications Drawings for cable sizes.

G. Base Bid Manufacturer:
1. AMP
2. General
3. Ortronics
4. Or equal

2.2 FIBER BACKBONE CABLE (INTRA-BUILDING)

A. Application: Use for intra-building (riser/feeder) data backbone cabling.

B. Compliance: Must comply with ANSI/TIA-568-B standard specifications.

C. Characteristics: Cable:
1. Will support 10 Gps for a minimum of 150 meters.
2. 12-strand multimode ~~and 12-strand singlemode~~
3. Shall be UL listed type OFNP (Plenum-rated)
4. Dielectric strength member
5. Tight buffer design construction
6. Maximum short term pulling tensile of 600 lbs. (272.16 kg) and long term pulling tension of 200 lbs. (90.719 kg).

D. Characteristics Multimode fiber:
1. Laser Optimized, 10 Gig, 150 Meters
2. 50/125µm (core/cladding) dual window (850 and 1300 nanometers).
3. Maximum attenuation: 3.0 dB/km @ 850 nm and 1.0 dB/km @ 1300 nm.
4. Minimum bandwidth: 3000 MHz/km @ 850 nm and 500 MHz/km @ 1300 nm.
5. 275 numerical aperture ± 0.015

~~E. Characteristics Singlemode fiber:~~
~~1. Core Diameter: 8.2 um~~
~~2. Numerical Aperture: 0.14~~
~~3. Maximum attenuation: 0.32 dB/km @ 1310 nm and 0.18 dB/km @ 1550 nm.~~
~~4. Effective Group Index of Refraction: 1310 nm: 1.4676; 1550 nm: 1.46.82~~
~~5. Rayleigh Backscatter Coeffieient (for 1 ns Pulse Width): 1310: -77 db; 1550 nm: -82 db~~

F. Refer to Telecommunications Drawings for cable sizes.

H. Base Bid Manufacturer:
   1. AMP
   2. General Cable
   3. Ortronics
   4. Or equal

2.3 FIBER OPTIC PATCH PANELS

A. Application: Use for housing fiber optic cable backbone terminations.

B. Compliance: Must comply with ANSI/TIA-568-B.3 standard specifications.

C. Characteristics:

   1. Rack-mount 4U fiber optic patch panels shall be provided in quantities adequate to support multimode fiber optic cable terminations in the MPOEs. Connector panels shall be loaded with multimode LC adapters with metal inserts.

   2. Rack-mount 1U fiber optic patch panels in IDFs. These patch panels shall be capable of supporting multimode SC connector terminated fibers.

   3. Multimode LC duplex adapters with metal inserts shall be provided equal to terminated multimode fiber optic cable strands.

   4. Fiber optic cables shall be terminated in adapters in each fiber optic patch panel.

   5. Fiber optic patch panels shall be fully loaded either with adapter panels or adapter and blank panels.

   6. Fiber optic patch panel shall include strain relief supports.

D. Base Bid Manufacturer
   1. AMP
   2. Panduit
   3. Ortronics
   4. Or equal

2.4 FIBER OPTIC CONNECTORS

A. Application: Use for termination of multimode and fiber optic backbone cable.

B. Compliance: Must comply with ANSI/TIA-568-B.3 standard specifications.

C. Fiber Optic Connector types: LC duplex multimode ~~and singlemode~~

D. Base Bid Manufacturer:
   1. AMP
   2. Panduit
   3. Ortronics
   4. Or equal

2.5 MULTIMODE FIBER OPTIC PATCH CORDS

A. Application: Use for interconnecting fiber optic backbone cable.

B. Compliance: Must comply with ANSI/TIA-568-B standard specifications.

C. Provide the following patch cord quantities and lengths for MPOE.
1. Multimode thirty-six (36) 2 meter, orange
~~2. Singlemode thirty-six (36) 2 meter, yellow~~

D. Provide the following patch cord quantities for building IDFs.
1. Multimode thirty-six (36) 2 meter
~~2. Singlemode thirty-six (36) 2 meter~~

F. Base Bid Manufacturer
1. AMP
2. Panduit
3. Ortronics
4. Or equal

2.6 MISCELLANEOUS FIBER OPTIC TERMINATION CONSUMABLES

A. Provide all miscellaneous consumables necessary to support, breakout and terminate multimode fiber optic cable.

2.7 INNERDUCT

A. All inter-building fiber optic backbone cable shall be installed in MaxCell inneduct unless otherwise noted.

B. Fiber installed with UTP copper cable in 4” conduit shall be installed in 2” Maxcell innerduct.

C. Intra-building fiber optic cable installed above corridor ceilings, shall be installed in 1” plenum-rated corrugated innerduct.

D. Intra-building fiber optic backbone installed in riser and feeder conduits shall be installed in 1” riser-rated corrugated innerduct.

E. One fiber optic cable shall be installed per innerduct or innerduct cell.

F. Three 3-cell MaxCell innerducts shall be installed in inter-building 4” conduits supporting multiple fiber optic cables.

G. See Section 270528 for additional innerduct requirements.

H. Manufacturer
1. MaxCell
2. Carlon
3. Endot
4. Or equal

2.8 COPPER BACKBONE CABLE (INTER-BUILDING)

A. Application: Use for voice backbone connectivity between MPOEs and each building entry IDF.

B. Compliance: RUS Specification PE-89.

C. Characteristics:

1. Conductors: Solid, annealed copper, 24 AWG unless noted on design documents.
2. Insulation: Dual insulation consisting of an inner layer of foamed polyolefin surrounded by a solid polyolefin skin.
3. Twisted Pairs: Insulated conductors twisted into pairs with varying lay lengths to minimize crosswalk.
4. Core Assembly: Cables of 50 pairs and less formed by assembling pairs together in a single group. Cables of more than 50 pairs formed by twisted pairs arranged in groups with each group having a color coded unit binder.
5. Filling Compound: Core assembly completely filled with ETPR compound, filling the interstices between the pairs and under the core tape.
6. Core Wrap: Non-hygroscopic dielectric tape applied longitudinally with an overlap.
7. Sheath
   a. Aluminum Shield: Corrugated, copolymer coated, .008 inches aluminum tape applied longitudinally with an overlap. The sheath interfaces are flooded with an adhesive water-blocking compound.
   b. Jacket: Black, linear low-density polyethylene.
   c. O.D. Inches: must not exceed 1.25”

D. Base Bid Manufacturer
1. General Cable
2. Superior Essex
3. Or District approved equal

2.9 COPPER BACKBONE CABLE (INTRA-BUILDING)

A. Application: Use for riser/feeder voice backbone connectivity between Telecommunications Rooms.

B. Compliance: Bellcore Specification TS-TSY-000111, UL Listed Type MPR/CMR, passes CSA FT4 Flame Test, ANSI/TIA 568B Category 3 specifications.

C. Characteristics:
1. Conductors: solid annealed copper conductors, 24 AWG.
2. Insulation: Dual insulation consisting of an inner layer of foamed polyolefin surrounded by a solid PVC skin, color-coded in accordance with telephone industry standards.
3. Twisted Pairs: Insulated conductors twisted into pairs with varying lay lengths to minimize crosstalk.
4. Core Assembly: Cable cores made up of 25 pair sub-units. Each group individually identifiable by color-coded unit binders. Each 25 pair-unit identified with a different binder color.
5. Core Wrap: Non-hygroscopic dielectric tape applied longitudinally with an overlap.

~~6. Alvyn Sheath~~
~~7. Aluminum Shield: Corrugated, adhesive coated, 0.008 inches (0.2032 mm) aluminum tape applied longitudinally with an overlap.~~
~~8. Jacket: CMR or CMP (as required per building conditions)~~
~~9. Cable sizes defined in Contract Documents.~~

~~D. Base Bid Manufacturer~~
~~1. General Cable~~
~~2. Superior Essex~~
~~3. Or equal~~

~~2.10 COPPER BACKBONE TERMINATION HARDWARE~~

~~A. See Section 271100 for 110 wiring block termination hardware requirements.~~

~~2.11 PROTECTOR PANELS AND UNITS~~

~~A. See Section 271100 for Protector Panel and Unit requirements.~~

PART 3 EXECUTION

3.1 PVC AND PLENUM-RATED CABLING

A. Horizontal as well as backbone cabling shall be rated to meet ASU Fire Marshal requirements, building combustible and non-combustible requirements as well as local building codes.

3.2 BACKBONE CABLE INSTALLATION

A. Backbone cables shall be installed separately from horizontal distribution cables.

B. All fiber backbone cable will be installed in corrugated or multi-cell innerduct.

C. A nylon pull cord, 0.125 inch (3.175 mm) minimum shall be co-installed with all cable installed in any conduit.

D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.

E. Where backbone cables and distribution cables are installed on cable runway or wire managers, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

F. All backbone cables shall be securely fastened to the sidewall and near room corners of IDFs.

G. Vertical runs of cable shall be supported to D-rings, J Hooks, cable tray, or other method to provide proper support for the weight of the cable.

H. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

I. Contractor shall install mounting/racking hardware within vaults and hand holes as required. All innerduct and cable shall be neatly dressed and secured in Maintenance and Hand holes.

END OF SECTION

SECTION 271500 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.1 WORK INCLUDED

A. Installation and termination of Category 6 four pair UTP cabling at Telecommunications Outlet locations as indicated on Telecommunications Drawings for voice, data, and security cameras.

1.2 SUBMITTALS

A. Refer to Section 270001 for submittal procedures.

B. Provide submittals for materials required by this section.

C. Submittals shall consist of catalogue cut sheets and/or engineering specification sheets provided by the manufacturer.

1.3 PVC AND PLENUM-RATED CABLING

A. Horizontal as well as backbone cabling shall be rated to meet building requirements as well as local building codes and fire marshal requirements.

PART 2 PRODUCTS

2.1 CATEGORY 6 UTP 4 PAIR CABLE

A. Compliance: Must meet FCC Part 68 certification and comply with ANSI/TIA-606 labeling standards.

B. Application: Use for horizontal voice and data cabling between IDFs and workstation locations.

C. Compliance: Listed as complying with ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 Category 6 specifications and associated addendums. All conductive cabling and associated components must comply with Article 800 of the NEC.

D. Characteristics:
   1. UTP Plenum-Rated Cable: Features are as specified for cables, conductors, and UTP workstation cable. Plenum-rated cable shall meet applicable requirements of ANSI/ICEA S-80-576, and shall be UL certified to conform to UL910, CMP and shall be marked as such.
   2. UTP PVC Cable: Features are as specified for cables, conductors, and UTP workstation cable. Non-plenum rated cable shall meet applicable requirements of ANSI/ICEA S-80-576, and shall be UL certified to conform to UL910, CMR and shall be marked as such.

3. Shall consist of (4) 24 AWG twisted pairs.
4. Shall be suitable for the environment in which they are installed.
5. Cable shall be third party verified to meet ANSI/TIA-568-B.1 and ANSI/TIA-568.B.2 Category 6 specifications and associated addendums.
6. All horizontal data station cables jacket color shall be blue in color.
7. All horizontal data station cables shall terminate on rack-mount patch panels within their respective Telecommunications Room.

E. Manufacturer
1. AMP
2. General Cable
3. BerkTek
4. Or Equal

2.2 CATEGORY 5E UTP 4 PAIR CABLE (Alternate)

A. Application: Use for horizontal voice and data cabling between IDFs and workstation locations.

B. Compliance: Listed as complying with ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 Category 5e specifications and associated addendums. All conductive cabling and associated components must comply with Article 800 of the NEC.

C. Characteristics:

1. UTP Plenum-Rated Cable: Features are as specified for cables, conductors, and UTP workstation cable. Plenum-rated cable shall meet applicable requirements of ANSI/ICEA S-80-576, and shall be UL certified to conform to UL910, CMP and shall be marked as such.
2. UTP Non-Plenum Cable: Non-plenum rated cable shall meet applicable requirements of ANSI/ICEA S-80-576, and shall be UL certified to conform to UL910, CMR and shall be marked as such.
3. Shall consist of (4) 24 AWG twisted pairs.
4. Shall be suitable for the environment in which they are installed.
5. Cable shall be third party verified to meet ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 Category 5e specifications and associated addendums.
6. All horizontal voice station cables jacket color shall be white in color.
7. All horizontal voice station cables shall terminate on wall-mount 110 wiring blocks in their respective Telecommunications Room.

D. Manufacturer
1. AMP
2. General Cable
3. BerkTek
4. Or Equal

2.3 110 WIRING BLOCKS

A. See Section 271100 for 110 wiring block requirements.

2.4 CATEGORY 6 CONNECTORS (MODULAR JACKS)

A. Compliance: Listed as complying with ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 Category 6 specifications and associated addendums. Must comply with ANSI/TIA-606 labeling standards.

B. Characteristics:
1. Work area cables shall be terminated at their designated work area location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a faceplate.
2. Modular jacks shall be 8-position modular jacks. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.
3. Modular jacks shall have 568B-wiring label.

C. Modular jacks shall be permanent and compliant with ANSI/TIA 606 standard specifications. Hand printed labels shall not be accepted.

D. All data modular jack assemblies shall be white in color.

E. Manufacturer
1. AMP
2. Panduit
3. Leviton
4. Or Equal

2.5 CATEGORY 5E CONNECTORS – MODULAR JACKS

A. Compliance: Listed as complying with ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 Category 5e specifications and associated addendums. Must comply with ANSI/TIA-606 labeling standards.

B. Characteristics:
1. Work area cables shall be terminated at their designated work area location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a faceplate.
2. Modular jacks shall be 8-position modular jacks. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.
3. Modular jacks shall have 568B-wiring label.

C. Blank filler will be installed when extra ports are not used.

D. Modular jacks shall be permanent and compliant with ANSI/TIA 606 standard specifications. Hand printed labels shall not be accepted.

E. All voice modular jack assemblies shall be white in color.

F. Manufacturer
   1. AMP
   2. Panduit
   3. Leviton
   4. Or Equal

2.6 UTP PATCH PANELS

A. See Section 27 11 00 for patch panel requirements.

2.7 FACEPLATES (WALL-MOUNTED)

A. The faceplates shall:
   1. Be UL listed and CSA certified.
   2. Be from the same manufacturer as modular jacks.
   3. Be constructed of high impact, ABS plastic UL 94V0-0 construction UON.
   4. Match the faceplate color used for other utilities in the building.
   5. Be available as single-gang or dual-gang.
   6. Be six-port configuration.
   7. Possess recessed designation windows to facilitate labeling and identification.
   8. Have mounting screws located under recessed designation windows.
   9. Allow for UTP modules to be inverted in place for termination purposes.

B. Base Bid Manufacturer
   1. AMP
   2. Panduit
   3. Leviton
   4. Or Equal

2.8 FACEPLATES (WALL-MOUNTED TELEPHONE OUTLET)

A. The faceplates shall:
   1. Be UL listed and CSA certified.
   2. Be from the same manufacturer as modular jacks.
   3. Be constructed of high impact, ABS plastic UL 94V0-0 construction UON.
   4. Shall have mounting posts to support vertical mounted telephone units.
   5. Faceplate color to be coordinated with architect.
   6. Allow for UTP modules to be inverted in place for termination purposes.

B. Manufacturer
   1. AMP
   2. Panduit
   3. Leviton
   4. Or Equal

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

A. All installation work shall be performed according to published industry guidelines, rules, and regulations. If disputes occur, local, state, and national codes have precedence; then Owner standards; then standards such as ANSI/TIA; then guidelines from firms such as Building Industry Consulting Services International (BICSI); and then finally, manufacturer recommendations.

B. The contractor shall provide sufficient trained staff to monitor all work undertaken and to ensure that the requirements of these specifications are met throughout the installation process.

C. All tests will be conducted using equipment that has laboratory or manufacturer certified calibration within six months of the tests. The contractor shall provide a signed copy of the calibration test results for each item of test equipment with the acceptance documentation.

D. All installation work will be of the highest quality. The contractor shall at all times make every effort to conduct all installation work in a manner so as to minimize the impact on the facilities. Whenever possible, all work will be hidden behind finished materials and all surfaces will be returned to their original condition.

E. The contractor shall provide and install all cable support hardware necessary to successfully complete the installation. This includes, but is not limited to, hangers, ladder racks, support brackets, earthquake bracing, firestop materials, tie-wraps, and access openings such as core drills. Conduit and sleeves shall be provided and installed by the electrical contractor.

F. The contractor shall ensure that only staff fully qualified to work on specific types of materials are allowed to undertake the required installation. Particularly, staff that is manufacturer certified shall only undertake copper and fiber optic cable placement, termination, splicing, and testing.

G. The contractor shall provide all hardware, miscellaneous components necessary to provide a complete system.

H. The bend radius of any cable installed must not exceed the manufacturer's specifications.

3.2 HORIZONTAL STATION CABLING

A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.

B. A nylon pull cord, 0.375 inch (3.175 mm) minimum shall be co-installed with all cable installed in any conduit.

C. Cable raceways shall not be filled greater than the ANSI/TIA-569-A maximum fill for the particular raceway type or 40 percent.

D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.

E. The cable's minimum bend radius and maximum pulling tension shall not be exceeded.

F. Cables from the conduit stubs to the cable tray shall be supported with J-hooks at a maximum of 48 inches (1.2 meter) intervals. At no point shall cables rest on conduits, plumbing, ducting, acoustic ceiling grids/panels, etc.

G. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

H. Cable shall be installed above fire-sprinkler 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.

I. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.

J. 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.

K. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA-606. 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 and behind patch panels.

L. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.

M. Pulling tension on 4-pair UTP cables shall not exceed 25 lbs/ft. (11.34 kg/m) for a four-pair UTP cable.

N. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 document, manufacturer's recommendations and best industry practices.

O. Pair untwist at the termination shall not exceed 0.5 inch (12 mm).

P. Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.

Q. The cable jacket shall be maintained to within 1 inch (25 mm) of the termination point.

R. Voice and Data jacks, unless otherwise noted in drawings, shall be located in voice and data, and voice, data and video faceplates. Jacks in horizontally oriented faceplates shall be installed left to right.

S. Voice and Data jacks shall be terminated per ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2 standards. All unused faceplate openings shall have blanks installed.

T. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the contractor shall submit the proposed configuration for each outlet assembly for review by the Owner.

U. Cables shall be stored in a Figure-8 in the ceiling space if adequate space is present to house the cable storage without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12 inches (304.8 mm) of UTP slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be loosely coiled in a Figure-8 and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

3.3 WIRELESS ACCESS POINTS

A. Contractor shall provide and install cables to support wireless access points (WAPs). The WAP locations shall be installed inside and outside the Instructional Building #1. Exterior WAPs shall be installed in exterior enclosures and shall face the pool areas.

B. Contractor shall provide and install two (2) Category 6, 4-pair cables terminated in 2-port surface mount blocks per access point location.

C. Surface mount blocks shall be located above ceilings in the Instructional Building #1 and in exterior mounted J-boxes. The exterior enclosure shall be mounted over J-boxes.

D. Contractor shall coordinate J-box mounting heights with owner and architect prior to installation.

3.4 WIRELESS ACCESS POINT AND SECURITY CABLE LOCATIONS

A. Contractor shall provide and install cabled outlets to support wireless access points and security cameras.

B. For Wireless Access Points (WAPs):
1. Contractor shall provide and install two (2) yellow in color, Category 6, 4-pair cables each terminated to 8-position, RJ-45, Category 6 jacks mounted in 2-port surface mount blocks per access point location.
2. Surface mount blocks shall be located above ceilings in the Instructional Building #1 and in exterior mounted J-boxes.
3. WAP and Security Camera cabling shall terminate in a dedicated 24-port Category 6 patch panel.

4. Contractor shall coordinate J-box mounting heights with owner and architect prior to installation.

C. For Security Cameras:
1. Contractor shall provide and install one (1) green in color, Category 6, 4-pair cable terminated to an 8-position, RJ-45, Category 6 jack mounted in 1-port surface mount block within camera housing.
2. Surface mount blocks shall be located above ceilings in the Instructional Building #1 and in exterior mounted J-boxes.
3. WAP and Security Camera cabling shall terminate in a dedicated 24-port Category 6 patch panel.
4. Contractor shall coordinate J-box mounting locations with Security Contractor prior to installation.

3.5 TELECOMMUNCIATIONS OUTLET CONFIGURATIONS

A. Contractor shall provide and install voice, data and voice cabling in the following configurations:

B. Voice Only Outlets: (1) Voice – Supported by the installation of:
1. (1) White in color, Category 6, 4-pair, station cable terminated to (1) 8-position, RJ-45, Category 6 modular jack.

C. Data Only Outlets: (1) Data – Supported by the installation of:
1. (1) Blue in color, Category 6, 4-pair, station cable terminated to 8-position, RJ-45, Category 6 modular jack.
2. Blank all unused faceplate ports.

D. Standard Telecommunications Outlets: (1) Voice and/or (1) Data – Supported by the installation of:
1. Voice – (1) White in color, Category 6, 4-pair, station cables terminated to (1) color TBD, 8-position, RJ-45, Category 6 modular jack.
2. Data – (1) Blue in color, Category 6, 4-pair, station cables terminated to (1) color TBD, 8 position, RJ-45, Category 6 modular jack.
3. Floor monument standard voice and data outlets require single-gang 106 frames (color TBD) for mounting all voice and data jacks.
4. Blank all unused faceplate ports

E. Standard Telecommunications Outlet with Audio Visual: (1) Data – Supported by the installation of:
1. (1) Yellow in color, Category 6, 4-pair, station cable terminated to (1) color TBD, 8 position, RJ-45, Category 6 modular jack.
2. Blank all unused faceplate ports.

F. Standard Camera Outlet with (1) Data – Supported by the installation of:
1. (1) Blue in color, Category 6, 4-pair, station cable terminated to (1) color TBD, 8 position, RJ-45, Category 6 modular jack.
2. Blank all unused faceplate ports.

3.6 IDENTIFICATION AND LABELING

A. All label printing will be machine generated. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

B. Label information shall include apartment number and jack number. Labeling scheme must be owner-approved before installation.

3.7 AS-BUILT DRAWINGS

A. Cabling Contractor shall provide full-size as-built drawings. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined in an Cabling Contractor provided jack matrix. Numbering conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in electronic (DWG, AutoCAD, latest release) formats on which as-built construction information can be added. These documents will be modified accordingly by the Cabling Contractor to denote as-built information as defined above and returned to the Owner.

B. Cabling Contractor shall provide half-size laminated as-built drawings. The Cabling Contractor shall frame and mount these drawings on a wall in each IDFs and the BDF Room.

3.8 WARRANTIES

A. The Cabling Contractor shall provide a 2-year warranty on the physical installation.

B. An Extended Product Warranty shall be provided from the Product Manufacturer, which warrants functionality of all components used in the system for no less than 20 years from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and backbone copper UTP, and the backbone fiber optic portions of the cabling system. The Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA-568-B.1 and ANSI/TIA-568-B.2. These applications included, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, Fiber Channel FC-PH and 155 Mbps ATM. The Cabling Contractor shall be certified to install the product to qualify for the Manufacturer Extended Product Warranty.

3.9 FIRESTOP

A. A firestop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.

B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure).

Any penetrating item (i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc.) shall be properly fire stopped.

C. All firestop systems shall be UL approved and shall be installed by the Cabling Contractor in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

END OF SECTION

SECTION 274116

AUDIO-VIDEO SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

A. GENERAL CONDITIONS

1. The Invitation for Bids, Instruction to Bidders and General Conditions of the contract including any supplementary conditions apply to all work under this section.

2. The contractor acknowledges and warrants that he has closely examined all the contract documents, that they are suitable and sufficient to enable the contractor to complete the work in the time allotted for the contract sum as accepted by the CM and AV consultant, and that they include all work, whether or not shown or described, which reasonably may be inferred to be required or useful for the completion of the work in full compliance with all applicable codes, laws, ordinances, rules, and regulations.

3. Execution of the contract by the contractor is a representation and warranty that the contractor has carefully examined the contract documents, and represents and warrants that the contractor is thoroughly familiar with the nature and location of the work, the site, the specific conditions under which the work is to be performed, and all matters which may in any way affect the work or its performance. The contractor further represents that as a result of such examinations and investigations, the contractor has thoroughly reviewed and understands the contract documents and their intent and purpose, and is familiar with all applicable codes, ordinances, laws, regulations and rules as they apply to the Work, and that the contractor will abide by same.

4. Claims for additional time or additional compensation as a result of the contractor's failure to follow the foregoing procedure and to familiarize itself with all local conditions and the contract documents will not be permitted.

5. Related Work Specified Elsewhere:

   A. All Division 1 Specification Sections apply to this Section.

   B. Power, signal conduits and back-boxes provided and installed under Division 26; except loudspeaker back-boxes and specialty back-boxes provided under this work for installation under Division 26.

B. INSTRUCTIONS TO BIDDERS

1. Definitions:

   A. Bidding documents include the proposed contract documents, which consist of the project specifications herein and the associated AV category drawings.

B. A bid is a complete and properly signed proposal to do the work as described in the contract documents, for the sums stipulated therein, submitted in accordance with the bidding documents.

C. The work includes all tasks necessary to complete the contract as described in the contract documents.

D. A bidder is a person or entity that submits a bid for coordinating and/or performing all the work as described in the contract documents.

E. A sub-bidder is a person or entity who submits a bid to a bidder for materials, equipment, and/or labor for a portion of the work.

F. The owner is Compton Community College District and its affiliates and subsidiaries.

G. The CM (CM) - Representative.

H. The architect is DLR Group.

I. The AV consultant is PlanNet Consulting.

2. Bidding Documents:

A. Copies:

1. The CM will issue bidding documents directly to the bidders.
2. Bidders shall be responsible for providing copies of the bidding documents to sub-bidders to solicit services to be sub-contracted.
3. In making copies of the bidding documents available on the above terms, the AV consultant does so only for the purpose of obtaining bids on the work and do not confer a license or grant permission for any other use of the bidding documents.

B. Interpretation or Correction of Bidding Documents:

1. Bidders and sub-bidders shall carefully study and compare the bidding documents with each other to the extent that it relates to the work for which the bid is submitted, and shall promptly notify the AV consultant of any ambiguity, inconsistency, or error which they may discover.
2. Bidders and sub-bidders requiring clarification or interpretation of the bidding documents shall make a request to the AV consultant through the general contractor at least five (5) working days prior to the date of receipt of bids. Requests for information (RFI) shall be written and faxed to the CM. No questions will be answered by telephone.
3. The AV consultant will make clarifications by addendum and/or by written response if deemed necessary.

C. Addenda:

1. Each bidder shall ascertain, prior to submitting a bid that the bidder has received all addenda issued, and the bidder shall acknowledge their receipt in the bid.
2. Consideration of bids

D. Rejection of Bids:

1. The CM and the AV consultant shall have the right to reject any or all bids and to reject a bid not in compliance with bidding procedures and requirements, no accompanied by data required by the bidding documents, or in any way incomplete or irregular.
2. The CM and the AC consultant shall also have the right to reject any or all bids when, in their judgment, it is in their best interest to do so.

E. Acceptance of Bid:

1. The CM and the AV consultant will be the final judge of which bid is accepted.
2. The CM and the AV consultant shall have the right to waive informalities or irregularities in a bid received and to accept a bid which, in their judgment, is in their best interest.

3. 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. Audiovisual Drawings provide additional general construction requirements.

C. Exhibit B: Major Equipment and Approved Manufacturers List.

D. Specification 274130 – Assistive Listening Systems (ALS)

4. SUMMARY OF WORK – <u>The AVC shall provide the AV system designs using the owner furnished contractor installed (OFCI) to provide a complete turn key solution with the equipment specified and additional parts required for a functional system.</u>

A. Classroom Type 1 (101, 102,105,106, 201, 204, 205, 206, 260) – Short Throw Projector

1. The audiovisual systems shall provide capability for presentations, and both audio and video playback. The following describes the equipment and capabilities of this room.
2. Video reproduction shall be via one (1) wall-mounted 3300 lumen projector (1280 x

800, 16:10 aspect ratio). The image shall be projected on an OFE whiteboard with the image filling the whiteboard top to bottom and the width as much as possible.

3. Stereo audio sources shall be summed and reproduced via four (4) recessed loudspeakers in the drop tile ceiling. Audio content shall be a monaural output and evenly distributed through-out the ceiling using a 70V audio amplifier built into the switcher; the speakers shall be secured with a minimum of one (1) seismic wire on each speaker to the hard-lid ceiling above the drop tile ceiling.

4. There shall be an assisted listening system (ALS) in each classroom with an inferred (IR) radiator and IR receivers (Stethoscope receiver, and Neck Loop for a T-Coil) for use by students with a hearing impairment.

5. There shall be one (1) wireless lapel type microphone for use in the classroom. This shall be used for capturing the instructor's voice for the ALS system and voice reinforcement for soft spoken instructors.

6. Sources shall include inputs with a HDMI and VGA/stereo audio cables for laptops and other portable equipment like a document camera if available.

7. There shall be one (1) cable cubby in the AV rack/cart with one set of multimedia input cables (HDMI, VGA/stereo audio cables). These shall be located on the top of the rack/cart; the location in the top of the rack/cart shall be confirmed with the client and the cut out opening for the cubby shall be provided by the AVC.

8. There shall be a rolling AV rack/cabinet with doors front and back and a slim power strip with basic surge protection to house the AV equipment, cable cubby with control panel.

9. Control of the AV equipment and projector in the room shall be via control system in the AV switcher/scaler and through the control panel in the top of the cable cubby. The control system shall control source selection, ON/Off functionality for the complete system from a single button, room volume control, microphone volume level, and display image freeze if available. When a source button is pressed on the control panel, the displays shall turn on, switch to the appropriate input. Sources that have additional functionality or messages shall have a pop-up window with additional controls or text for the button that was pressed (Laptop – HDMI, Laptop VGA, Help Desk) to guide the user for additional action.

B. Classroom Type 2 (103, 104, 202, 203) – Ceiling Mounted Projector

1. The audiovisual systems shall provide capability for presentations, and both audio and video playback. The following describes the equipment and capabilities of this room.

2. Video reproduction shall be via one (1) ceiling-mounted 5000 lumen projector (1280 x 800, 16:10 aspect ratio). The image shall be projected on an OFE whiteboard with the image filling the whiteboard top to bottom and the width as much as possible.

3. Stereo audio sources shall be summed and reproduced via four (4) recessed loudspeakers in the drop tile ceiling. Audio content shall be a monaural output and evenly distributed through-out the ceiling using a 70V audio amplifier built into the

switcher; the speakers shall be secured with a minimum of one (1) seismic wire on each speaker to the hard-lid ceiling above the drop tile ceiling.

4. There shall be an assisted listening system (ALS) in each classroom with an inferred (IR) radiator and IR receivers (Stethoscope receiver, and Neck Loop for a T-Coil) for use by students with a hearing impairment.

5. There shall be one (1) wireless lapel type microphone for use in the classroom. This shall be used for capturing the instructor's voice for the ALS system and voice reinforcement for soft spoken instructors.

6. Sources shall include inputs with a HDMI and VGA/stereo audio cables for laptops and other portable equipment like a document camera if available.

7. There shall be one (1) cable cubby in the AV rack/cart with one set of multimedia input cables (HDMI, VGA/stereo audio cables). These shall be located on the top of the rack/cart; the location in the top of the rack/cart shall be confirmed with the client and the cut out opening for the cubby shall be provided by the AVC.

8. There shall be a rolling AV rack/cabinet with doors front and back and a slim power strip with basic surge protection to house the AV equipment, cable cubby with control panel.

9. Control of the AV equipment and projector in the room shall be via control system in the AV switcher/scaler and through the control panel in the top of the cable cubby. The control system shall control source selection, ON/Off functionality for the complete system from a single button, room volume control, microphone volume level, and display image freeze if available. When a source button is pressed on the control panel, the displays shall turn on, switch to the appropriate input. Sources that have additional functionality or messages shall have a pop-up window with additional controls or text for the button that was pressed (Laptop – HDMI, Laptop VGA, Help Desk) to guide the user for additional action.

C. Conference Room 161

1. Conference Room 161 shall allow the end users to conduct meetings and presentations, there shall be sources such as a laptop, and other auxiliary portable equipment.

2. The contractor shall provide and install one (1) wall mounted 55" consumer LED flat panel display with a resolution of 1920 x 1080 (16:9) in the conference room.

3. Stereo audio sources shall be summed and reproduced via two (2) loudspeakers mounted in the ceiling. Audio content shall be a monaural output and distributed throughout the ceiling using a 70V audio amplifier built into the switcher; the speakers shall be secured with a minimum of one (1) seismic wires.

4. Audio and video from inputs in the flip-top cubby on the rack/cabinet shall be reproduced via the ceiling mounted speaker.

5. There shall be an assisted listening system (ALS) in the conference room with an

inferred (IR) radiator and IR receivers (Stethoscope and Neck Loop for a T-Coil) for use by people with a hearing impairment.

6. There shall be a rolling AV rack/cabinet with doors front and back and a slim power strip with basic surge protection to house the AV equipment, cable cubby with control panel.

7. One (1) flip-top cable cubby shall be mounted into the rack/cabinet in the conference room and shall connect laptop computers, and other auxiliary video equipment. The contractor shall coordinate the integration of the cubbies into the rack/cabinet with the architect and owner. The cable cubby connections shall be VGA with stereo audio, and HDMI connection. Power and data connections shall also be available at the cable cubby.

8. The opening in the rack/cabinet top for the flip top cable cubby shall be provided by the AVC. Before cutting the openings in the table top the contractor shall provide a drawing of the table top indicating the cubby location for review and signoff by the CM and owner. Before actually cutting the contractor shall markup the cubbies locations on the table top before making the first cut in the table top for a final review by the client.

9. One (1) set of multimedia input cables (HDMI, VGA / stereo audio) shall be available for connection of auxiliary portable devices such as laptop computers in the room.

10. Control of the AV equipment and projector in the room shall be via control system in the AV switcher/scaler and through the control panel in the top of the cable cubby. The control system shall control source selection, ON/Off functionality for the complete system from a single button, room volume control, microphone volume level, and display image freeze if available. When a source button is pressed on the control panel, the displays shall turn on, switch to the appropriate input. Sources that have additional functionality or messages shall have a pop-up window with additional controls or text for the button that was pressed (Laptop – HDMI, Laptop VGA, Help Desk) to guide the user for additional action.

D. Paging System

1. There shall be a paging system <u>speaker</u> provided ~~and installed~~ by the AVC and <u>installed by the GC</u>. The paging speakers shall be installed in the Lobby, and hallways (public and office areas) on the first and second floors. Refer to sheets T2.01 and T2.02 for the approximate speaker locations.

2. The headend of the paging system shall be in the IDF room with the telephone systems. The AVC shall confirm the rack location and the connection to the telephone system for a line level output for the mixer/DSP unit. The AVC shall work with the schools' IT department to set-up and test the connection to the telephone system, and test the paging levels in all areas.

C. SCOPE:

1. Supply and install sound and video systems including all apparatus and equipment, wiring, termination, labor, and services required to provide systems as specified and shown on drawings.

2. If equipment has been discontinued or at "end of life", the equipment shall be substituted with the newest like model available from the same manufacture. If a different manufacture or model of equipment is to be substituted, the substitution must be reviewed by the Consultant and Client for approval.

3. Supply and install any incidental equipment needed in order to meet the functional requirements stated herein and on drawings. This shall include all support and restraint for the fixed loudspeakers and projection equipment.

4. Set up and adjustment of specified hardware and software.

5. Furnish all test equipment and the services of the project engineer and the project manager to assist the CM's representative in the acceptance testing.

6. Make any adjustments to any part of the system, including the re-aiming of loudspeakers, which may be found necessary during the acceptance testing.

7. Provide training in the operation of the systems to the person or persons selected by the CM.

D. COORDINATION:

1. Schedule installation operations in sequence required in order to obtain best completion results.

2. Coordinate the procurement and installation of the projection screens, projector mounts and all loudspeakers with the CM and Owner.

3. Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.

4. All specialty sub-contracting including coordination of all telecommunications lines with other subcontractors and equipment as shown on the contract documents to be coordinated by the contractor.

E. EQUIPMENT AND MATERIALS

1. The contractor shall verify characteristics of elements of interrelated equipment specified under this section are compatible; coordinate work having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

2. By making requests for substitutions, the contractor:

a. Represents that he has personally investigated the proposed substitute product and determined that it is equal to or superior in all respects to that specified.

b. Represents that he will provide the same warranty for the substitution that the Contractor would for that specified.

c. Certifies that the cost data presented is complete and includes all related costs under this contract, and waives all claims for additional costs related to the substitution which may later become apparent.

d. Will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects, including, but not limited to, in full compliance with all applicable codes, laws, ordinances, rules, and regulations and completion in the time allotted for the contract sum as accepted by the CM and AV consultant.

F. SCHEDULE

1. Within ten (10) calendar days of the receipt of the notice to proceed the contractor shall prepare and submit for approval, in accordance with the general conditions, a schedule which shall include, but is not limited to, the following:

A. Submission of shop drawings, samples and layouts for all items described herein.

B. Start and Completion date(s) for field installation work.

1. Installation date(s) of all wires and cables in conduits and required cable trays.

2. Date when fully-operational equipment racks will be fully tested and ready for Consultant's observation.

3. Delivery date(s) of all systems and subsystems to the project site.

C. Start and completion date(s) for shop fabrication work.

D. Date of submission of samples for approval by the architect of all finishes/materials which will be visible to the public. Refer to Part 1 paragraph 1.8 entitled "Submittals" for additional information.

E. Programming of all remote control and digital signal processing driven devices.

F. Completion dates(s) for the following tests:

1. Performance tests on all individual AV components as they are received from the manufacturer in the contractor's shop.

2. Performance tests on completed assemblies and subassemblies assemblies, including all racks in the contractor's shop.

3. Performance tests on the completed systems as a whole prior to shipment to the project site.

4. General performance testing of systems at the project site.

G. Completion dates for the following shop and field observations.

1. Shop fabricated assembly and subassembly observation.

2. Substantial completion observation at the project site.

3. Final acceptance observation at the project site.

H. Submission date for operating, maintenance manuals, as-built drawings, documentation and closeout materials.

2. In the event the contractor wishes to deviate from the schedule once it is established and approved, he may do so only after receiving written approval from the CM.

G. SUBMITTALS

1. All submittals shall be in accordance with the general provisions of the contract, including general and supplementary conditions and other Division 1 Specification Sections.

A. AV consultant will not review partial submittals.

B. AV consultant will review up to two (2) submittals of any one submittal topic.

3. Substitutions of equal equipment beyond the alternatives listed will be permitted only in accordance with Division 1. If a requested substitution requires a change in any of the contract drawings, a revised drawing must be submitted as part of the substitution request. If an alternative listed is discontinued prior to installation, the contractor shall submit a substitution request to provide the manufacturer's replacement model. The AV consultant shall be the final judge of the acceptability of substitutions.

4. All drawings shall be clear and legible. The minimum text size for all drawings shall be 1/8" high.

5. Post Award Submittals: submit within 60 days of award.

A. Submit electronic reproducible drawings (as .dwg and .pdf), documents (as .pdf) and software as per manufacturer's directions of the following:

1. A statement of subcontractors, franchises, distributorship, dealerships, arrangements and agreements with manufacturers of equipment to be used for this work.

2. Complete bill of quantities, including all material, components, devices and equipment required for this work. The bill of quantities shall be tabulated respective of each and every system as specified, in the order of the specification section 2 below, and shall contain the following information for each item listed:

    A. Quantity
    B. Description
    C. Manufacturer's name and model number
    D. Manufacturer's specification sheet

B. Samples of approval by the Architect of all finishes/materials which will be visible to the public. Including at least receptacles and controls with associates trim plate and each type of loudspeaker baffle and/or grille.

C. Schedule for work as described herein showing all major milestones.

D. Floor plans, at scale of contract documents, showing the locations throughout the project of all receptacles, conduits, wireways, trays, pull boxes, junction boxes, equipment racks equipment and other devices with appropriate designations and fill.

E. Riser diagrams, showing all elevations, room numbers, conduit sizes, types and fills, box sizes and types, devices, equipment and rack designations.

F. Functional Diagrams: single-line block diagram showing interconnection of all components, receptacles, terminal blocks, controls, transformers and loudspeakers in addition to the active elements. Include terminal and cable numbers, all system and component labels. Show detailed system component information including but not limited to manufacturer's name, model number, any specialized part number option and all input and output connection information, for each piece of equipment. No drawing codes shall be permitted. Mount one (1) full-scale original or photograph (not blueprint) copy behind acrylic in the control booth for each system.

G. Equipment rack elevation drawings scaled (1-1/2" = 1'-0" or larger):

1. Front Elevations: include equipment designation, manufacturer's name, model number, rack location and rack designation.

2. Rear Elevations: include AC power wireways and route of wiring harnesses.

H. Samples for approval by the architect of all finishes/materials that will be visible to the public including at least receptacles and controls with associated trim plate and each type of loudspeaker baffle and/or grille.

I. Cable schedules and run sheets, associates with each equipment rack and/or any isolated piece of equipment or device, including cable designation, type, manufacturer and manufacturer's type number, wire color, device and terminal designation and device location, keyed to both the system block diagram and equipment rack elevation drawings.

J. Contractor fabricated items, detailed drawings showing all components, devices and equipment, including dimensions, component values, terminal designations, types, locations, manufacturer's name and model number.

K. Loudspeaker cluster and monitor loudspeaker supports stamped and signed by an engineer licensed in the project state. Include all loads, location of attachment to building structure, complete layout of all components, devices and equipment, including dimensions, methods of assembly, and connections to supporting construction, details of hardware, locations, manufacturer's name and model number. All design calculations, loads, etc. shall be shown. Drawings shall be 1/4" = 1'-0" scale minimum. Permissible scales shall be 1/4", 3/4", 1", 1-1/2", and 3" = 1'-0" and full scale.

L. A bound volume or volumes of comprehensive specifications for all material, devices, components and equipment selected for use in this section, whether modified or not, provided as required under "Post Award Submittals" above.

M. Control panel Layouts: Developed drawings of all control system panel layouts.

6. Digital Signal Processor (DSP) System Submittal for CM Review:

A. Prior to programming the Digital Signal Processing (DSP) system, the contractor shall submit shop drawings per the project standards showing all screen layouts and control descriptions of all system functions to the CM for review and comment prior to actual programming of the system. Shop drawings shall include screen layouts of the DSP software "control pages" for all "configuration-presets" and "parameter-presets". Submit electronic versions of the DSP software to the Consultant for review and approval. The contractor shall incorporate all CM comments into the programming of the systems.

B. Prior to delivery of the systems to the job site, the contractor shall demonstrate fully functioning systems in the contractor's facilities that include the DSP system programming. This demonstration shall coincide with the CM's Representatives observation of completed sub-assemblies (Refer to Part 3 paragraph **Error! Reference source not found.** entitled "System Performance Tests"). The CM will review and comment upon the

remote control programming, and the Contractor shall incorporate all CM comments into the programming of the systems.

C. After the installation of the AV systems has been deemed substantially complete, but prior to final acceptance of the system, the CM shall have a review period of thirty (30) days to observe the operation of the DSP system. At the end of this review period, the CM may request programming changes relating to the look and feel of the operation pages or the functionality of commands. The contractor shall make these changes prior to acceptance of the systems.

7. Control System Submittal for CM Review:

A. Prior to programming the remote control system, the contractor shall submit shop drawings per the project standards showing all control screen layouts, graphical user interfaces (GUI) and control descriptions of all remote control system functions to the CM for review and comment prior to actual programming of the system. Submit in native file format and hard copy form. Shop drawings shall include control screen layouts of the touch panel pages for each venue, web page layouts (as required in Part 2 below). Submit electronic versions for CM review. The contractor shall incorporate all CM comments into the programming of the systems.

B. Prior to delivery of the systems to the job site, the contractor shall demonstrate fully functioning systems in the Contractor's facilities that include the remote control programming. This demonstration shall coincide with the CM's representative observation of completed sub-assemblies (Refer to Part 3 paragraph **Error! Reference source not found.** entitled "System Performance Tests"). The CM will review and comment on the remote control programming submittal, and the contractor shall incorporate all CM comments into the programming of the systems.

C. After the installation of the AV systems has been deemed substantially complete, but prior to final acceptance of the system, the CM shall have a review period of thirty days to observe the operation of the remote control system. At the end of this review period, the CM may request programming changes relating to the look and feel of the remote control panels or the functionality of commands. The contractor shall make these changes prior to acceptance of the systems.

D. Digital Signal Processing and control system programming files, touch panel, & other control page & Graphical User Interface layouts in native file format and hard copy form.

8. Shop Test Statement Submittals:

A. Submit electronically - photographs and state of the following prior to shipping fabricated equipment racks to Project site:

1. A bound volume, or volumes, of results of performance tests and adjustment data, including all test procedures specified in Part 3 paragraph **Error! Reference source not found.** entitled "System Performance Tests". Example shop test statement submittal templates are available from the AV consultant upon request.

2. Submit a written request for equipment rack observation certifying that equipment racks are completely assembled, tested and ready for inspection.

3. Detailed interior and exterior photos of assembly supporting claim for readiness for inspection.

9. Final Submittals: Submit the following Record Drawings developed from the final "As-Built" systems:

A. Two (2) copies and one (1) reproducible of each of the block diagrams, plans, risers, patch bay drawings, rack elevations, cable schedules and detail drawings. All reproducible drawings shall be submitted on CD-ROM.

1. One (1) complete set of Functional diagrams ½ size drawings.

2. One (1) additional set of rack elevation drawings and sheets provided in the drawing package.

B. No more than thirty (30) days after Acceptance Testing, submit two (2) copies of each of the following equipment cut sheets and manuals prior to, and as a requirement of, CM acceptance of the work of this section:

1. Equipment operating instructions; complete, comprehensive instructions for the operations of all contractor-fabricated devices and equipment items provided as part of the work of this section.

2. Manufacturer's cut sheets, installation, operating and service information including schematic diagrams for each item of equipment furnished. Order the equipment manuals in the order of the specifications. Provide tabs between each equipment manual. Provide a detailed index at the front of each manual indicating specification reference number, manufacturer's trade name, model number and part description. Provide two (2) copies to the CM after they have been reviewed and approved by the AV consultant.

3. Printed material within contractor-fabricated equipment and systems operating manuals shall be bond paper copies, offset or letterpress printed. Drawings, charts and graphs shall be bond paper offset printed. The systems contractor-fabricated equipment instruction manuals shall be composed using a single, consistent visual format and writing style; text shall be derived from component equipment manufacturer's instruction manuals and may include reproductions of artwork and other materials.

C. Submit two (2) copies of each of the following schedules, lists, and data prior to, and as a requirement of, CM acceptance of the work of this section:

1. All source code for any contractor provided or programmed equipment on CD-ROM.

2. Final bill of quantities; complete bill of quantities all material as delivered, including a separate schedule of portable equipment.

3. Equipment schedule; complete, final schedules of equipment and devices provided in each room, by room number and name.

4. Performance, test and adjustment data; comprehensive documentation of all performance verification and correction procedures and measurements, including raw and equalized house curves and equalizer settings.

5. Maintenance and spare parts schedules; a comprehensive tabulation of equipment, devices, miscellaneous parts and maintenance items, including manufacturer's name, address, model number, systems use and miscellaneous information.

D. No more than thirty (30) days after Acceptance Testing, provide one (1) copy of the following:

1. Certificates; any and all licenses, certificates of operation and/or compliance as required.

E. The system will not be accepted until these documents are reviewed and approved by the CM's representative.

H. QUALITY ASSURANCE

1. Unless otherwise stated, all electrical, electronic and optical equipment shall be a product of firms regularly engaged in the manufacture of electrical, electronic or optical equipment. The equipment shall be the latest model or type offered which meets the applicable specifications at the time of the submittal. Discontinued items replaced by newer models or versions are prohibited and should not be submitted for review. It shall be the contractor's responsibility to provide the AV consultant with information regarding discontinued products listed as alternatives in the specification. If an alternative listed is discontinued prior to installation, the contractor shall submit a substitution request to provide the manufacturer's replacement model.

2. Quality of workmanship and fabrication of all equipment and components, which are custom fabricated shall be comparable to processional equipment produced by specialized manufacturers of the trade involved and shall be verified by observation. Only firms having 10 years' experience in all aspects of the fabrication and installation of similar systems shall be allowed to perform the work.

3. All materials and products shall be new and of processional quality. Unless specifically stated in the drawings or specifications, no existing or pre-owned materials shall be installed.

4. The work specified herein, and in each of the allied sections, shall be accomplished by a single contractor experienced in the design, fabrication, installation, checkout and warranty contract management of systems such as those described in each section. This contractor shall have complete responsibility for the systems described herein and shall be the single contract point for the architect, the AV consultant and/or the CM with respect to all work specified herein.

I. WARRANTY AND SERVICE

1. The contractor shall warrant the installation free of faulty workmanship.

2. All components, including solid-state devices, warranted free of defects for a period of one (1) year from date of final acceptance. This minimum warranty provision shall not diminish the terms of individual equipment manufacturers' warranties.

3. Paint and exterior finishes, fuses and lamps excluded from above warranties except when damage or failure results from defective materials or workmanship covered by warranty.

4. Provide maintenance service for a period of one (1) year after acceptance of installation. Service to consist of at least two (2) semiannual visits to the site software updates, and equipment adjustments. These visits should be coordinated with CM or representative.

5. Service request response time: Provide two (2) hour via telephone / email, with 24-hour on-site technical response time. Provide a technician on call from 7 a.m. to 9 p.m. five (5) days a week.

6. All repairs must be completed within 10 business work days. If repairs cannot be completed within 10 working days, a replacement/loaner must be provided. If it cannot be resolved within the 10 days, the CM or CM representative will have the option of getting it repaired with the contractor covering the costs.

PART 2 - PRODUCTS

2.01 General:

A. Appendix A - Refer to the attached Major Equipment and Approved Manufacturers List.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The following installation requirements shall govern the design, fabrication and installation of the system(s) specified herein. In case of a discrepancy between these overall system standards and the individual equipment item specifications, the latter shall govern:

1. The equipment specified shall be installed according to standards of good human engineering practice and the conditions specified herein.

2. Workmanship on the installed systems shall be of processional quality, best commercial practice and accomplished by persons experienced in the techniques and standards of the particular industries involved.

3. The specifications describe required performance. The specifications with the contract drawings indicate a general design; it is the intention of the specifications that the Contractor will supply from his background of experience and knowledge the necessary supporting details; for example, the implementation of specific components into functioning sub-systems.

4. In general, the drawings show dimensions, positions, and kind of construction. The specifications describe materials, qualities and methods. Any work called for on the drawings and not mentioned in the specifications, or vice versa, shall be performed as though fully set forth in both. In case of differences between the drawings and the specifications, the decision of the CM's representative shall govern. Work not particularly detailed, marked or specified, shall be construed to be the same as similar parts or areas that are detailed, marked, or specified.

B. Equipment markings shall present only needed information and be readable from the operator's normal work position. These markings shall be designed to minimize ambiguous interpretation.

C. Control panels shall be designed to reduce chances of human error and controls shall be natural and consonant with normal operator expectations.

D. All control consoles and their panel mountings shall be provided with the necessary controls, indicators and switches, etc., as outlined in the pertinent sections of this specification. The grouping of these facilities shall be in accordance with the associated drawings and shall, in all cases, be arranged to present an orderly, functional appearance. The layout of controls shall be such that priority of accessibility shall be given to those facilities which frequently require attention.

E. The total design of the system shall simplify the operator's task and insure maximum performance and reliability while minimizing possibilities for human error and providing a comfortable environment for the operator during operation.

F. At the operational level (i.e., patch panels, AV equipment receptacle boxes, etc.) all receptacles shall be clearly marked by function and number. When there are multiples of the same function for example, a given microphone line may appear at several locations, the same label shall be shown at each location.

3.02 The Conduit System:

A. The AV category drawings indicate the number, type and location of the receptacle, wire and cable requirements and Equipment Room layouts, which are the responsibility of the contractor. The conduit diagrams indicate schematically the functions served by the conduit system. Also, the conduit diagrams may indicate the locations at which functions are served at several locations in the facility. See the general installation notes for additional information and requirements as shown on the AV category drawings.

B. The Electrical Contractor is bound to provide the conduit system shown on the AV category drawings as part of the base building contract.

1. If any portion of the conduit installation is concurrent with the AV contract, the contractor shall inspect the work at appropriate times during construction and report any discrepancies to the architect and CM in writing. The contractor shall coordinate the exact location of intermediate collector boxes behind the equipment rack with the electrical contractor.
2. The Electrical Contractor is bound to verify continuity of all conduits as described in the AV category drawings with a yellow pull string.

C. The contractor shall be responsible for supplying any additional conduit that may be required to complete the system installation in accordance with the drawings.

D. It shall be the responsibility of the contractor to obtain the exact location of any pull boxes, "LBs" or other intermediate locations from the Electrical Contractor.

E. The contractor shall also verify that conduits are adequate for the wiring and functions specified. If the contractor substitutes the specified wiring the contractor shall bear the sole responsibility for reengineering the conduit system.

F. The Contractor shall field verify all back box installation conditions on site and shall size connection panels as described below. Notify the CM and AV consultant of any discrepancies between AV drawings and installation conditions.

1. Surface Mounted Back Boxes: Connection panels shall be sized to match the outer edges of the installed back box and shall have smooth edges.
2. Recessed Mounted Back Boxes: Connection panels shall be sized to overlap the outer edges of the installed back box by 1" in both horizontal and vertical directions and shall be installed tightly against the wall surface finish.

G. Each conduit shall contain wires or cable of the same signal level or the same type of circuitry only. Each separate service level designation shown on the AV conduit riser shall be run in their respective, separate conduits and all conduit landings in backboxes or equipment racks shall be grouped by service level.

H. Ground power conduits to the power system ground. Do not connect power system conduits to the racks or to the audio system ground.

3.03 Equipment Rack Assemblies:

A. General:

1. Equipment rack shall be completely assembled, tested and programmed in the contractor's shop. No rack assembly shall be performed at the project site. After the equipment rack is tested the contractor shall notify the CM's representative in writing that the equipment rack assemblies are ready for observation and approval. Allow adequate time for any modifications necessary to satisfy the contract drawings and specifications.

2. Use rear and mid rails for intermediate terminations. Maintain accessibility to the rear of the equipment.

3. Mid rails must be used to support equipment weighing more than 50 pounds.

B. Wiring Harnesses:

1. Equipment rack wiring shall be "Harness" style. "Point to Point" rack wiring is not acceptable. The individual wiring harnesses shall be located at the rear of the equipment rack on the sides and individual pairs of cable shall be broken out on to lacing bars to the back of the equipment to the connectors.

2. Electrical service levels shall not be mixed in an individual harness. It is the intent that there will be a separate harness for each electrical service level.

3. Great care shall be exercised to keep low level signal harnesses separated from the AC power lines and high level signal harnesses.

C. Equipment Labels:

1. Rack-mounted equipment shall be labeled on front and back, as to function using engraved black/white laminated plastic blocks. For example: LEFT HI-FREQ AMPLIFIER or CENTER EQUALIZER

2. Use permanent processional quality labels such as "Gravelply" or approved equal. Stick-on strip labels such as those from Dyno or Brother are not acceptable.

D. Internal A/C Receptacles:

1. Maintain grounding as described in the herein.

2. Locate all internal AC receptacles on the left side of the rack and all harnesses on the right side of the rack. In the event that there are 2 equipment racks side by side locate the AC receptacles in the middle of the equipment racks and the wiring harnesses to the outer sides.

E. Installation:

1. No equipment may be installed prior to the following:

   a. The AV consultant has performed the AV equipment rack observation in the contractor's shop.
   b. Any and all punch list items described as 'minimum to enable rack delivery to site' have been addressed, proof has been submitted to AV consultant, and AV consultant has approved rack delivery to site.
   c. Notice has been filed with the CM, the architect, and the AV consultant that a 'dust-free' environment has been achieved in the project in all areas where audiovisual system equipment is to be installed. Dust-free shall be defined as follows: all floor, wall, ceiling construction, millwork, finishes (including paint), carpet, hardware, electrical, and HVAC is absolutely complete (and tested and fully operational in the case of electrical and HVAC systems) before AV equipment racks may be delivered to the site.

2. All stationary equipment rack(s) shall be secured to the building structure to meet seismic and code requirements.

3. Great care shall be exercised to keep low level signal lines separated from the AC power lines and high-level signal lines.

4. All audio field lines entering the equipment rack must be connected to equipment. Video field lines may be connected directly to the switcher or patch bays. In the event that a patch bay with an E3 or E90 connectors is used, the patch bay may serve as the terminal block. This will also facilitate the testing of the systems in the contractor's shop.

5. All connections of lines at terminal blocks, as well as at signal receptacles, shall be mechanically secured and then soldered. No unsoldered connections shall be permitted. Where lines approach the racks and terminal blocks they shall also be mechanically anchored at the rack, and provided with sufficient slack length to avoid strain, abrasion or wear.

F. Wiring and Cabling:

1. Extreme care must be taken to physically segregate and separate all high level lines from lower level lines.

2. Control cables and power distribution wiring shall not be installed adjacent to signal cables. Power distribution cabling shall be on the opposite side from signal wiring in equipment enclosures and shall be uniformly located throughout an installation.

3. All wire and cable utilized in systems interconnection shall be of the flame-retardant type (FR-1 flame test).

G. Penetrations of Cabling in Construction:

1. All cabling or system interconnection which passes through or into acoustically isolated areas, such as sound locks and studios, shall be suitably sealed after cable has been installed.

2. Contractor shall provide all necessary fire stopping of openings through which cable is installed under this specification in accordance with NFPA 70 and all local codes. This includes installation in conduits, raceways, or bare penetrations in fire-rated barriers. All contractor installed "fire stop systems" must be UL approved including fire stop material (Fire Barrier Caulk), which must be UL 1479 approved.

H. Wire Labels:

1. During installation both ends of all wires or cables shall be clearly labeled with approved wire labels.

2. The wire labels shall be numbered consecutively with respect to the patch bay with a leading service level designation. If there are no patch bays utilized in the system the wire labels shall be numbered consecutively with a leading service level designation.

3. The wire labels shall not be more than 8 inches or less than 4 inches from the connector or termination at each end of the cable.

4. Wire labels shall utilize plastic shrink-wrap, protecting the text and ensuring they remain affixed to the wiring. Approved: Thomas and Betts or approved equal, submit sample to the CM's representative.

I. Documentation:

1. Maintain a careful running log of route and terminations for each cable.

2. A detailed wiring diagram shall be furnished with wire numbers shown as part of the as-built documentation. All spare cable shall be shown on the As-Built documentation.

J. Cable Management:

1. Cables shall be grouped and bundled by type and routed from source to termination in a uniform manner throughout all equipment housings. Care shall be taken not to break the insulation or deform the cable by harness supports. Cables shall not change relative position in a cable group throughout a cable route.

2. Cable support bars shall be installed to support cables in areas of dense harness breakouts such as behind patch panels, distribution amplifiers and other multiple input/output devices.

3. Edge protection material ("cat track") or grommets shall be installed on the edges of holes, lips of ducts or any other point where cables or harnesses cross metallic edges.

K. Terminations:

1. The contractor shall employ the latest termination practices and materials.

2. Signal and control cable ends shall be neatly formed, and shrinkable tubing shall be applied where necessary to secure the insulation against fraying or raveling.

3. Field terminations shall be made with terminal blocks.

4. Internal rack terminations and field terminations shall be made with terminal blocks.

5. Punch block terminations are not acceptable and shall not be allowed.

6. Coaxial connectors shall be crimp-on and then soldered. Audio and control wires shall be terminated with crimp-on lugs, and then soldered.

7. Digital media cabling – submit proof of applicable cable termination training prior to installation and terminate per manufacturer's detailed instructions.

8. All bare wire shall be tinned prior to termination unless the connector manufacturer recommends otherwise.

9. Unused line level shields shall be individually insulated using shrinkable tubing and attached to the cable using an additional piece of shrinkable tubing.

L. System Grounding:

1. The "spider" concept is designed to avoid ground loops and inductive coupling.

2. The systems shall be hum free, stable and free of oscillation with the earth ground temporarily disconnected.

3. The earth ground shall be made at only one point in the system as indicated and shall be in accordance with National Electric Code 2002 paragraphs 250.146(D), 406.2(D) and 408.20 Exception.

4. The grounding method shall insure that the system is free of the following problems under any mode of operation:

   a. RF oscillation, pickup and interference.

b. Distortion.

c. Crosstalk.

d. Signal Leakage.

e. Very high frequency feedback.

f. Audio Hum.

5. Major wiring ducts or trays shall be grounded to the conduit system.

6. The equipment racks shall be isolated from, and not electrically bonded to, the building conduit system. This means that the conduit system shall not be electrically connected to the equipment racks and that the equipment racks shall be installed so that they are electrically isolated from the building structural steel. The racks shall be electrically bonded at only one point to the isolated grounding system as shown on the AV category drawings.

M. Seismic Restraints:

1. All hanging or free-standing equipment and cabinets furnished including but not limited to racks, loudspeakers, projection screens, and TV monitors shall be secured to substantial building structures. The equipment described shall resist seismic acceleration in any direction up to a limit of the greater of 1.0 G or the limit prescribed by the local governing codes.

2. Maintain electrical isolation between the equipment racks and building steel.

3. Loudspeaker hanging details, rack bracing, and other seismic restraints are not shown on the contract drawings; it shall be the Contractor responsibility to develop these drawings.

4. Submit loudspeaker mounting (rigging) drawings to the Architect for review after they have been stamped and signed by a licensed structural engineer engaged in regular practice in the Project's State.

N. Audio System Processing Adjustments:

1. The contractor shall program the Digital Signal Processing system to include filters adjusted such that the loudspeaker zone(s) effected by same are measured to exhibit uniform (flat) frequency response (less than +/- 3 dB) at the listening location for the frequencies the transducer is designed/intended to address. Measurements utilized for determining filter adjustments shall be made on axis with respect to a single transducer (representative of the zone) in its intended field of coverage. Loudspeaker cross-over filters shall be provided first for all actively crossed transducers per loudspeaker manufacturer's instructions. Additional filters will still be required to achieve uniform frequency response measured at the various listening locations. For loudspeaker zones of small transducers, utilize high-pass filters first and foremost and then utilize

parametric EQ filters to flatten the measured response. For loudspeaker zones of large transducers, where other transducers in the system will address higher frequencies, utilize low-pass filters first and foremost and then utilize parametric EQ filters to flatten the measured response.

2. The contractor shall program the Digital Signal Processing system to include delay settings adjusted so that the direct sound from the main loudspeaker clusters and the delay zone transducers in question arrives simultaneously at the listening plane served by the delay zone transducers. The AV consultant may add additional delay to address 'imaging / Haas effect preferences' as appropriate.

3. The AV consultant may add additional filters and delay (as required) to address 'tuning preferences', but such 'tuning preferences' shall not be considered as part of the base line requirements for determining substantial completion of the audio system. Flat frequency response and time alignment of the direct sound from the loudspeakers will be considered a base line requirement for determining substantial completion of the audio system.

O. Loudspeaker Installation:

1. Verify all loudspeaker aiming and positioning with CM's representative.

2. Submit loudspeaker mounting (rigging) drawings to the architect for review after they have been approved and signed by a certified structural engineer engaged in regular practice in the Project's State.

P. Video Projector Installation:

1. The video projector shall be converged, registered and color balanced. Obtain from the CM all scan rates and resolutions that are to be used and properly converge the projector for all possible inputs. In addition, the contractor shall optimize the projector for the following standard scan rates and resolutions:

   A. HDTV, 720p, 1080i and 1080p

   B. 1280 x 800, 60Hz, 70Hz, and 75Hz

   C. 1440 x 900, 60Hz, 70Hz and 75Hz.

   D. 1600 x 1200, 60Hz, 70Hz and 75Hz.

   E. 1920 x 1080, 60Hz, 70Hz and 75Hz

   F. 1920 x 1200, 60Hz, 70Hz, and 75Hz

3.04 SYSTEM PERFORMANCE TESTS:

A. The contractor shall pre-assemble and test all systems and sub-systems in his own facility before completed assemblies are delivery to the project site.

B. Tests shall include but are not limited to those listed below in order to verify that the system meets all design requirements.

C. The contractor shall perform the initial system testing and adjustment prior to scheduling the final system acceptance tests.

D. All tests shall be fully documented and a neat copy presented for review by the CM's representative and inclusion in the system manual.

1. Performance Tests on Individual Components:

2. Perform in Contractor's facility.

3. Verify that the manufacturer's specifications are met.

4. Measure and record the impedance on each driver, and verify the acoustical output and freedom from rattles and distortion of all loudspeakers.

E. Performance Tests on Completed Component Sub-assemblies:

1. Perform in contractor's facilities.

2. Before delivery of the equipment to the project site, the specialty contractor shall demonstrate to CM's representatives at the contractor's facilities that all sub-assemblies are operating as specified.

3. Verify the achievement of the specifications for each electronic component in situ, i.e., as assembled in its console, rack or other enclosure, powered by the system power supply and with all other components also activated, i.e., powered and interconnected. The magnitude and character of the threshold noise shall be observed for appearance of hum in excess of that present with individual activation, or the appearance of high frequency oscillation.

4. Projection equipment shall be tested to verify that the manufacturer's specifications are met after it has been incorporated into a complete subassembly.

5. Video equipment shall be tested to verify that its operation meets the manufacturer's specifications and EIA RS-170A after assembly into complete subsystems.

F. Performance Tests on the Complete System:

G. Verify that all wiring is correctly and completely installed. Verify that there are no short circuits between conductors within any cable, or from cable to cable. Verify the integrity of each conductor, i.e., that the conductor is not open circuited. In addition, the correct polarity of each connector, including those in patch panels, shall be verified and the color-coding scheme shall be recorded and included in the documentation provided to the CM's representative.

H. Verify that the entire system performance is in accordance with the design requirements. Specific attention is directed to the following for each system:

1. Projection Equipment.
2. Source Equipment Transports
3. Video Matrix Switchers.
4. Remote Control Components.
5. Video Distribution Amplifiers.
6. Audio Amplifiers.
7. Consoles.
8. Networking Equipment.

I. The threshold noise output of the system, measured at the output of the power amplifier, must equal the input when its gain control is full on, and of the line or booster amplifier input when all channel controls are off. No hum shall be audible in the system within the noise signal, or with the inputs terminated in microphone impedance and all controls full on. No high frequency oscillation shall be observed at the system output. No audible radio signal shall be detectable in the system at any control setting. Depending upon the proximity of a local radio station or upon the cable configuration of the system, RF oscillation or leakage may be a problem and the Contractor shall be prepared to install a RF low pass filter appropriately in the system as a final remedy.

J. Cross talk between channels shall be measured with signal equivalent to 1.0 Volts output into one channel with its gain off and the gain of each other channel varied over their full range. Maximum signal leakage at the system output must be equivalent to -70 dB re 1.0 Volt at the pre-amp output at 1 kHz, increasing to -52 dB at 8 kHz.

K. The general performance of each loudspeaker unit in situ shall be verified by applying pink noise signal at 10.0 Volt level and verifying the specified output SPL at a distance of 1 foot. Normal undistorted sound quality shall be verified by headphone listening at the output of the calibrated system. Each loudspeaker shall also be fed with an oscillator signal at 10.0 Volt level within its intended frequency range, verifying absence or abnormal distortion of rattles due to installation.

L. The audio system shall be adjusted as specified above in paragraph **Error! Reference source not found.** entitled "Audio System Processing Adjustments" where minimum requirements for establishing readiness for the substantial completion observation of an audio system are specified.

M. The complete video system shall be tested in the following manner: All video outputs of the system shall conform to EIA RS-170A when typical inputs to the system are fed with a "known good signal" from a video signal generator.

N. Provide installation functionality test results report prior to substantial completion punch walk.

O. Test procedures for video systems shall conform to the following basic guidelines:

1. All equipment and video signal chains shall operate according to manufacturer's specifications and/or to the EIA RS-170A standard.

   a. Black level (using the brightness control).

   b. White level (using the contrast control).

   c. Correct Hue.

1. All video cameras shall be setup and adjusted for the following:

   a. Black balance.

   b. White balance.

   c. Range of zoom and iris function.

P. All these tests, and any others that the Contractor may wish for his own satisfaction, shall have been performed and successfully achieved before observation requested. The CM's Representative may request repetition and demonstration during observation of certain of these tests or other critical tests if problems become apparent. If specifications are not met, further observations will be at the Contractor's expense.

3.05 DEMONSTRATION AND ACCEPTANCE TESTING

A. Substantial Completion Observation:

1. The contractor shall file a written notice with the CM when all of the aids to use describe in "Submittals", above, have been submitted for approval, all tests described in above in "System Performance Tests", are complete and the test reports have been submitted for review and approval and the systems and sub-systems are ready for the Substantial Completion Observation.

2. The contractor shall be prepared to demonstrate the overall system performance including but not limited to functionality, control system programming, operation, optics performance and Digital Signal Processing software control (where applicable). The contractor shall be prepared to demonstrate proper gain structure and that base line EQ (equalization of uniform frequency response) settings and delay filters (time alignment) have been set. In addition the Substantial Completion Observation of the systems may include repetition or demonstration of any or all of the tests described in paragraph **Error! Reference source not found.**"System Performance Tests" above or other critical tests if problems become apparent and the specifications are not met. After the Substantial Completion Observation, written notice noting whether the systems meet the criteria set forth in the General Conditions for Substantial Completion, along with a list of items for the contractor to correct shall be provided to the contractor.

3. In the event that the systems are found not to be Substantially Complete, all of the costs including fees, travel and living expenses in connection with subsequent observations or corrective work shall be borne solely by the contractor. This includes new problems that arise during the course of the subsequent observations.

B. Acceptance Observation:

1. After the systems have been certified as Substantially Complete, and the contractor has filed written notice with the CM that the corrections ordered, have been completed, a Final Acceptance Observation shall be scheduled.

2. During the Final Acceptance Observation of the systems repetition or demonstration of any of the tests described in "System Performance Tests", above, or other critical tests if problems become apparent and the specifications are not met, may be requested.

3. Assist in performing final system adjustments and acceptance tests. Provide all labor, materials and tools necessary for these tests and adjustments. Provide all necessary test equipment to complete the tests.

4. Budget 24 working hours for the performance of these tests and adjustments with the CM's representative. If final acceptance is delayed beyond this period because the installation is not in proper working order or is incomplete, the contractor shall pay for all additional time and expenses for any resultant extension or re-scheduling of the acceptance testing period.

5. Any measurements of frequency response, distortion, noise or other characteristics and any adjustments deemed necessary may be performed on any item or group of items, including re-orientation of loudspeakers, to insure optimum performance of the system.

6. In the event that the corrections have not been completed to the satisfaction of the CM's representative, or new problems arise at the time of the Acceptance Observation, all costs including consulting fees, travel and living expenses in connection with subsequent observations or corrective work shall be borne solely by the contractor.

C. Acceptance:

1. After observations and tests indicate that the entire AV system and sub systems as specified herein and indicated on the drawings are in total compliance with the drawings and specifications, a letter indicating said compliance shall be issued.

2. Acceptance of the system shall be accomplished as described in the General Conditions.

3. Final acceptance of the installation will be granted when it is clear to the CM's representative and the architect that the following conditions have been met:

    a. All fixed equipment has been furnished and installed according to the drawings and specifications.

    b. All portable equipment has been turned over to the CM.

    c. All equipment and installation have been tested and shown to perform as specified.

    d. All instruction manuals, software source code and as-built documentation have been completed and delivered to the CM's representative.

4. The Warranty period will begin only when all of the above listed items have been performed to the satisfaction of the architect, CM and CM's representative.

D. TRAINING

1. Submit all training materials to the CM's representative for approval prior to scheduling training sessions.

2. Provide 24 hours of hands on training practical operation of the system to the CM's representative. Address in the training, the general configuration of the system, basic functionality, correct operation procedures, routine maintenance and upkeep.

3. Provide 4 hours of follow-up training within 3 months of the initial training to review aspects of the original training and provide instruction on specific troubleshooting issues the CM's representative raises during the training.

4. Record via video and audio all training sessions and provide 3 copies to the CM on DVD-R format.

END OF SECTION

SECTION 274130 – ASSISTIVE LISTENING SYSTEMS (ALS)

PART 1 - GENERAL

1.1 SUMMARY

A. The work includes the provision of Assistive Listening Systems (ALS) as part of the building project.

B. The fixed ALS shall function with the voice reinforcement systems to be installed by the Audiovisual Contractor or Owner.

C. In the absence of fixed ALS, portable ALS shall be provided to the Owner, where specified.

D. Scope of Work: The work shall consist of the design, provision, termination, testing, and documentation of a complete and fully functional ALS. The instructions in this section are specific to the ALS installations and should be read in conjunction with other contract documents as applicable.

E. Deliverables: Prior to ordering materials or commencing any construction activities, the contractor shall provide the Owner with a complete bill of materials, including all quantities of components, devices, equipment, and wiring required to complete this work.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS:

A. ALS equipment to be manufactured by Listen Technologies.

B. Fixed System: Provide complete system with accessories as described below.

C. Portable Systems: Provide complete systems with accessories as described below.

2.2 FIXED ALS IR EQUIPMENT

A. Wireless audio distribution system

1. Furnish and install an Infra-Red (IR) wireless assistive listening system. The assistive listening system (ALS) shall be capable of broadcasting mono or stereo channels on up to 4 Upper Band IR carrier frequencies. Stethoscope or Lanyard style IR Receivers shall be frequency agile and frequency set with a push button channel selector. The Lanyard style receivers will incorporate a stereo headset jack that allows the user to plug in a stereo headset. The receivers shall incorporate automatic signal mute or squelch when no IR signal is received. Receivers shall be powered by either standard AAA batteries offering up to 30 hours of use or NiMH battery packs offering up to 15 hours of use. Use of NiMH battery packs will require a recharging station. IR radiators

shall come in Grey or White, have all needed hardware for mounting on wall, ceiling, table-top or mic stand and have auto-off feature to preserve LED life. Listen Technologies Corporation products are specified.

B. System functions

1. The system in its most complete configuration shall provide all of the following functions by means of purpose-built professional equipment:
   a. Radiating modulated infra-red light at intensity sufficient to ensure strong signal reception anywhere within the conference venue (subject to the stated specifications of the radiators);
   b. Enabling conference "listeners" to receive, select and listen to distributed languages and audio channels within the conference venue, by means of infra-red receivers and headphones;
   c. Providing facilities for mounting the infra-red radiators and storing and recharging infra-red receivers.

C. Compliance

1. The system shall comply with all applicable regulations and standards for equipment of this type, and especially with the IEC 61603 part 7, the standard for digital infra-red transmission for audio signals for conference and similar applications and IEC 60914, the standard for conference systems. In addition, the system shall comply with all applicable international, national and local regulations for the design, construction and installation of electrical equipment.

D. System Audio Performance

1. The system shall have the following audio performance, measured from the audio input of a transmitter to the headphone output of a receiver:
   a. High sound quality with a system frequency response of 20 Hz - 20 kHz (+/- 1 dB) Line Input 63 Hz - 15 kHz (+/- 3 dB) System Specification (wireless end-to-end with LR-44)
   b. A signal/noise ratio of >70 dB (SNR) Line Input >60 dB (SNR) System Specification (wireless end-to-end with LR-44)
   c. THD at Nominal Level <0.1% (THD) Line Input <2% (THD) System Specification (wireless end-to-end with LR-44)

E. The Listen Technologies Listen IR Transmitter and Radiator System is specified.

1. Furnish and install the following:

Listen Technologies - LS-91-01
   a. Listen Technologies LA-84-01 Listen IR Stationary IR Transmitter/Radiator Combo (Qty: 1 ea.)
   b. Listen Technologies LT-4200-IR Intelligent DSP IR Receive (Qty. 2 each)
   c. Listen Technologies LA-401 Universal Ear Speaker (Qty: 2 ea.)

d. Listen Technologies LA-430 Intelligent Ear Phone/Neck-loop Lanyard. (Qty: 2 ea.)
e. Listen Technologies LA-381-01intelligent 12 unit charging Tray. (Qty: 1 ea.)
f. Listen Technologies LA-901 Listen Disinfecting Wipes (Cylinder 75 Count)
g. Listen Technologies ADA Access/Compliance signage kit (Qty. 1 ea.)

*The Americans with Disabilities Act (ADA) 2014 ADA Standards requires public facilities to provide auditory assistance devices.

Section: 706 Assistive Listening Systems

Table 219.3 Receivers for Assistive Listening Systems

The chart below highlights the CBC's requirements for the number of assistive listening receivers required in an assembly area:

Capacity of Seating in Assembly Area*	Minimum Number of Required Receivers	Minimum Number of Hearing-Aid Compatible Required Receivers
1 – 50 Seats	Two	Two
51 + Seats	**4% of the total amount of seating**	25%

PART 3 - TESTING

Following the installation of transmitters and antenna, each transmitter and receiver will be tested.

Transmitters shall support signal distribution at all specified channels at any position in the instructional room to which its use is dedicated.

Receivers shall be tested to verify function as specified by manufacturer.

END OF SECTION

SECTION 28 13 00 - ACCESS CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide all materials, hardware, software, fabrication, coordination efforts and installation, programming, testing, documentation, and training in conformity with manufacturers' documentation, specifications contained herein, and applicable Codes and authorities having jurisdiction for the implementation of a complete Access Control System (ACS).

B. The Security Contractor shall be responsible for coordination of all access control system related installation issues with all stakeholders, CCC IT Department, and other trades. This includes programming of all software and hardware, connections/interfaces. Coordination of conduit/pathways, and power requirements for security devices directly with electrical contractor when necessary to complete installation. See also 1.2 Project Scope, Paragraph E below.

C. The system design intent shall support a perimeter envelope that will have access control functionality primarily at the perimeter entrance doors, elevator lobbies and other specific doors and areas as shown on the Design Drawings. Interior spaces will include secure access to the residential cluster corridors, main cluster entry doors in the residence halls, elevator cab readers, the receiving dock, fitness room(s), and in the community center/dining hall. The ACS and VSS shall functionally integrate, thus allowing a visual image of a perimeter breach where cameras are placed. An example would be a "door forced open" alarm where the associated camera would show a visual image of the door in alarm condition.

D. Access controlled doors and perimeter "exit doors" will have door position switches that seal off the perimeter during off hours. If this perimeter is breached it will cause an alarm that will indicate a security breach at the monitoring station. In case of an emergency the access controlled doors can be "locked down". The perimeter doors will be unlocked during regular hours and controlled by credentials and schedules for off hours access. The inside areas shall be key controlled as defined by CCC. The keys shall be used for doors that need to be secure but not electronically controlled.

E. The Access Control system will be capable of fully supporting Elevator Cab Card readers which can restrict access to certain floors based on programmed access levels. If an individual does not possess a legitimate credential or access level, the car will not move, or will return to the ground floor. It will be the responsibility of the Security Integrator to coordinate with the Elevator Control Company for the proper installation and control of this functionality and of cable requirements within the elevator travel cable.

F. Alarm signals from the system shall register at the designated monitoring station as an "alarm". The alarm signal shall include the time, date, location, and ID number of the alarm point.

G. The Security Contractor shall be responsible for the programming and testing of the dual technology key-fobs provided by others or as part of the existing legacy system. These key-fobs serve as access to dorm space locks as well as provide access to the perimeter doors and community amenities. The Security Contractor shall test all dual technology key-fobs required for proper function on the legacy system and on the new installation, where required.

1.2 PROJECT SCOPE

A. The Contractor shall be responsible for fully implementing the functions described in the specifications and shown on the Design Drawings and Specification Documents, which may not show or list every item required or to be provided. When an item not shown or listed is clearly necessary for proper installation and operation of equipment or the system(s), the contractor shall provide this equipment, components, or software at no additional cost to the Owner.

B. Provide and submit all required documentation as a single submission at the beginning of the project, as outlined in the Submittals section and referenced elsewhere within this specification, including written notice prior to demonstration for Final Acceptance.

C. A Complete turnkey integrated (to Video Surveillance) access control system is defined as all Category 6 patch cords for connection to the dedicated security network, servers and/or appliances, all software, applications and all required licenses, control panels, enclosures, card readers, credentials, door contacts, request to exit devices, auxiliary inputs/outputs, (electrified door hardware if not specified and provided by others), lock control, power supplies, Fire Alarm Interface connections, access control system cabling infrastructure with cable testing and reports, all cabling/wiring not provided by others as referenced herein, make all adjustments and Programming, system test, checkout and Commissioning, provide all Shop Drawings and Data Sheet Submittals, Close Out Submittals including Test Reports, Operation and Maintenance Manuals, Training classes and materials, As Built or Record Drawings, and certify (submit Warranty Certificate) the entire integrated access control/video surveillance system solution needed to achieve a complete and functional system, as basis of the contract price.

D. The Integrated Access Control and Video Surveillance System shall communicate using the existing fiber optic network provided and installed by the Communications contractor. Refer to 28 23 00 Video Surveillance for details and requirements for the dedicated Security Network. Also see 2.2 System Overview section in this specification for additional information.

E. The Security Contractor shall coordinate and work in harmony with other trades on the project as well as with A/E personnel and contractors performing work under a separate contract where all work is contributing to the overall project. Cooperate fully with the Architect so work may be carried out smoothly, without interfering with or delaying work under this contract or work by Architect. This would include timely submission of project documents and/or notices of impending scheduled events or milestones where others are

required to attend or participate in reviews, site walks, testing, commissioning and demonstration for Final Acceptance with the A/E personnel.

1.3 RELATED SECTIONS

A. 28 23 00 Video Surveillance

1.4 REFERENCES

A. Each agency's relative codes, standards, and recommended practices apply to the Access Control System and its components as specified herein.

B. Published specifications, standards, tests, codes, or recommended standards of trade, industry, or governmental organizations apply to work in these Sections, including:

1. ADA - Americans with Disabilities Act
2. ASCII - American Standard Code for Information Interchange
3. ASTM - American Society for Testing and Materials
4. EIA - Electronic Industry Association
5. NEMA - National Electrical Manufacturers' Association
6. NFPA - National Fire Protection Association
7. CEO - California Electrical Code
8. NEC – National Electrical Code
9. UL - Underwriters Laboratories, Inc.
10. ASIS – American Society for Industrial Security
11. FCC – Federal Communications Commission
12. OSHA – Occupational Safety and Health Administration
13. IEEE – Institute of Electrical and Electronic Engineers
14. ANSI – American National Standards Institute
15. State and Local Fire Marshal

C. Electronic devices radiating "RE" energy shall comply with Federal Communication Commission regulations, particularly Part 15, and shall meet minimum Class "B"

requirements. Provide FCC certificate numbers indicating that the FCC has approved products.

D. Where any of the above standards or codes differs with the contract documents and specification, the more stringent requirements shall take precedence. Any cost necessary to meet any AHJ requirements shall be included in the Contractor's price.

1.5 QUALITY ASSURANCE

A. Contractor and any Subcontractors shall be responsible for and familiar with all city, county, state, and federal codes, rules, ordinance, and regulations of the AHJ and their interpretations, which are in effect for these Premises.

B. The latest issue of all recognized codes, standards, and recommended practices of the following agencies in effect on the date of award of a contract shall form a part of this specification.

C. A nationally recognized test laboratory shall list all equipment supplied where applicable.

D. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

E. All items of a given type shall be the products of the same manufacturer.

F. All items shall be new and of the latest technology and version-level; no discontinued models or products are acceptable.

G. No Beta products shall be offered or will be accepted.

H. The manufacturer, or their Authorized Representative, shall confirm that within 100 miles of the project site there is an established agency which:

1. Provides a full Service Operation and stocks a full complement of replacement parts.

2. Offers service during normal working hours as well as emergency service on all equipment to be furnished.

3. Will supply parts and service without delay and at reasonable cost.

I. The Contractor shall be a factory authorized representative of Paxton Access Control Systems Inc., licensed to sell, install, and maintain all system, subsystems, components, and software required in the United States, and shall present a copy of their certificate designating them as a factory authorized distributor/installer.

J. The Contractor shall have at least five (5) years' experience designing, selling, installing and maintaining Paxton access control systems, and shall possess all applicable Contractor licenses.

K. The Contractor shall make all required project documentation submissions is a timely manner to promote Architectural review and approval in a timely manner, and not negatively affect the project work schedule.

L. Skilled technicians are to perform all installation, commissioning, programming and testing and are, at a minimum, to be factory trained and certified to work with the Access Control System.

M. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.

N. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.

O. All software provided shall be the latest version available by the manufacturer upon final acceptance of the system. This includes Microsoft products contained as part of the system. All of the latest updates and patches shall be installed at the time of acceptance.

P. The Contractor shall make application for and obtain all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

1.6 SUBMITTALS

A. Provide the following Shop Drawings and Data Sheet documentation as a complete submission to CCC at the start of the project;

1. Data Sheet submittals indicating Manufacturers name, model number, and a full description of the component and UL Listing for all equipment supplied.

a. Provide a Data Sheet for every item listed in the Bill of Material.

b. Indicate or high light all model numbers of equipment to be reviewed prior to submission for approval.

2. Provide a complete Bill of Materials with quantities of equipment supplied.

3. Shop Drawing package shall be submitted as a single package detailed completely as a base for the As Built drawing package, including the following details;

a. Dimensioned elevations and details for all wall mounted ACP's. Provide one dimensioned wall elevation for every Access Control Panel provided for this project with unique identification. The elevation shall indicate vertical and horizontal wall space required for ACP in Telecom Rooms.

b. At the MDF/Head End ACP, provide enough room for As Built drawing storage as part of this ACP assembly. Contractor to include method to store As built drawings in the dimensioned Wall Elevation for this ACP drawing.

c. Rack Elevation(s) for rack mounted equipment. Provide one dimensioned rack elevation for all rack mounted equipment provided in the project, as well as consoles and fabricated equipment being supplied under this section.

d. Point-to-Point wiring diagrams showing all communications and I/O boards with serial addresses, a cable schedule, and wire terminations for all interconnected components including all fire alarm interface connections for all doors in the path of egress equipped with access control locking devices.

e. Device location floor plans.

f. Block Riser diagrams with Facility Power and Fire Alarm connections.

g. Device Schedules of all doors in the project.

h. Mounting details for all mounted components.

i. Door Hardware Details, depicting rough in, pathways and device location derived from coordination with Division 8.

4. Partial or "Typical" drawings will not be accepted.

5. All drawings shall be done in CAD drafting software.

a. Duplication of Design/Bid Drawings submitted as a Shop Drawing package shall be rejected.

6. If required, for a project that is an extension of an existing legacy system, The Security Contractor shall provide a list of new IP device mac addresses that require connection to an existing network. An approved IP Table of IP addresses shall be provided for these devices for connection to the network, so as to ensure compatibility with the legacy network architecture. Also, to support network switch port security, this list shall be used to program network switches restricting network connections to approved devices only, and unused ports turned off.

7. Training Program documentation, including name and qualifications/certificate of trainer(s), schedule of training, curricula, and written training materials. As built drawings shall be available as part of the Training program.

8. Service information, including address of nearest representative. Provide written approval from each manufacturer affirming that Contractor is certified and approved for systems installation and service for all systems in this Section.

B. Provide the following items subsequent to the Shop Drawings and Data Sheet submission;

1. Provide all Test Reports as indicated in Section 3.3 TESTS AND REPORTS when completed in a timely manner for approval.

2. Provide (5) complete Operation and Maintenance manuals for all approved equipment installed. This O&M manual shall be available for Training classes and be part of the Training materials. This document manual must be approved and available for use in Training and Final Acceptance.

3. Provide all documentation referenced in under the Warranty section referenced within this specification, and provide Warranty Certificate indicating customer name, site address, system under warranty, date warranty begins and ends, service department contact information and manufacturer contact information.

C. Submittals must be a complete package, as in all items listed above under Shop Drawings and Data Sheets shall be submitted at one time together as a package. Incomplete or partial Shop Drawings and Data Sheets submittals shall be rejected.

D. The Security Consultant and CCC reserve the right to reject any submittals determined to be incomplete.

E. Operation and Maintenance manual shall be submitted prior to demonstration for Final Acceptance and Training.

1.7 SUBSTITUTIONS

A. All materials and equipment shall conform to these specifications. No substitute materials, brands or manufacturers may be used, unless previously accepted in writing by CCC and the Security Consultant.

B. Manufacturers listed as acceptable are normally engaged in the type of work specified. The listing of equipment part numbers or particular types of systems by specific manufacturers is to establish the performance, quality and parameters of the equipment and material specified.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All equipment provided shall be new, not used, and shall be shipped in original packages to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturers' recommendations. Contractor shall provide any required protective covering during construction.

B. Components to be stored for future use shall be kept inside a well ventilated space protected from weather, damage, breakage, and scoring of finishes. The Contractor shall replace, at no expense to CCC, equipment and material damaged during storage and installation as directed by CCC.

C. Products delivered to the job site in racks and consoles shall be protected from dust, dirt and foreign matter. All racks and consoles shall be protected from dents, bumps and scratching. Contractor shall replace all parts damaged in shipping or in storage with new at no cost to the Owner.

D. Used components are not permitted for installation at the Premises.

1.9 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by the Owners, civil unrest, or acts of god.

E. Provide a Certificate of Warranty to include Site name, date Warranty begin and ends, Service Provider contact information, complete street address and phone number. Contractor and manufacturer(s) shall warranty all equipment, materials and installation labor for a minimum of one (1) year from the date of written notification of Acceptance by CCC.

F. During the Warranty Period, upon notification of a problem by CCC, the Contractor shall ensure that a competent and qualified field service technician arrives on site to correct the problem within 24 hours of notification. If a problem can be corrected remotely to CCC's reasonable satisfaction, the on-site arrival time commitment shall be waived.

G. At least sixty (60) calendar days prior to expiration of Warranty, Contractor shall provide CCC with post-Warranty maintenance contract proposals. The terms and condition of any such post-Warranty program shall be consistent with those offered to the provider's most favored customer(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Specifications, functionality, system capabilities and products outlined in this specification are based on Paxton brand hardware and the current release of Professional software. Paxton Access, Inc., 138 Commerce Center, Greenville, SC., 29615. Tel: 877-438-7298, email supportUS@paxton-access.com

2.2 SYSTEM OVERVIEW

A. The Access Control system shall operate on a dedicated security system network shared with the video surveillance system, forming the foundation of the Integrated Security System. This dedicated security network does not connect with the business network, however, this equipment is co-located in the same communications closet as the business network equipment, possibly in the same rack. Rack and wall space shall be provisioned for this equipment in the Communications Infrastructure design within the Telecommunications Closets. The specifications for this dedicated security system network shall be found in Section 28 23 00 Video Surveillance System.

1. The Access Control Block Riser Drawing shows access control system components wall mounted in the Communications Closets indicating a connection to a local Category 6 Patch panel or reference a network port connection for this equipment. The Security Contactor shall provide all fiber optic and Category 6 patch cords to connect the access control equipment to the dedicated security network.

2. The Video Surveillance System Block Riser shall indicate the Ethernet network switches connecting to the fiber optic backbone which is part of the Structured Cabling System, an engineered and certified system provided and installed by the Communications contractor. The Security Contractor shall not provide or install any cabling or fiber for the Security System Network except the patch cords as indicated.

3. There are dedicated fiber optic strands within the existing network assigned for use by the dedicated security network, and the Security Contractor shall coordinate what fibers are identified for his equipment prior to installing this equipment. These fibers shall be identified and recorded in the As built or Record Drawings and submitted as part of the Project Close Out documentation.

4. The Security Contractor shall incorporate all requirements of the dedicated network electronics as outlined in the 28 23 00 Video Surveillance Specifications for materials, labor and required testing including all required submissions of test documentation as part of the access control system and/or the Integrated Security System.

B. The access control system shall be an inter-connected group of components consisting of but not limited to the following devices:

1. Fiber optic and Category 6 patch cords
2. Access Control System Servers (ACSS)
3. Workstations (shall be shared with Video Surveillance)
4. Access Control Panels (ACP's)
5. Communication devices, media converters, Ethernet Extenders, etc
6. Access control software
7. Credential Readers

8. Credentials
9. Door Contacts
10. Request to Exit devices
11. Electrified Door Hardware
12. Input/Output Boards
13. Power Supplies and batteries
14. Local Door Alarms
15. Duress buttons
16. Other equipment as specified

C. Overall system capability

1. The system shall monitor and control facility access via electronic access controllers utilising card readers and keypad devices. It shall be implemented through TCP/IP architecture using the electronic single door controller approach via PoE infrastructure.

2. The system shall be capable of monitoring alarm points, controlling output devices, and managing lift control floors. The system shall maintain an audit trail of operator activity and all access control and alarm activity.

3. The system shall can start with a single door, and expanding one door at a time, to up to a minimum of 1000 doors

4. Each controller shall be able to manage the hardware necessary to secure one door. If entry and exit is required, only one controller shall be required. Each controller shall maintain a full database of information so that access decisions are made within a maximum of one quarter of a second in both online and offline states.

5. The access controller units (ACU) shall be capable of DHCP or static IP addressing.

6. The system shall allow unlimited workstations for programming and administration of the system including database management, report generation, and real-time monitoring of activity. No license keys or fees shall be required to install and operate the software on client workstations. A dedicated computer shall not be required (but shall be recommended) for large projects.

7. The system shall support 500 input/output controllers for monitoring the condition of external devices such as alarm contacts, push buttons, photo sensors, and

temperature points. The I/O controller shall be TCP/IP communications and shall be capable of DHCP or static IP addressing.

8. The user shall be able to launch the time and attendance, online video tutorials, documentation and card badge designer from the access control GUI home page.

9. The system shall support at minimum 50,000 unique credentials.

10. The system shall be scalable, allowing for additional hardware from the same manufacturer.

D. The ACS shall provide the following as a minimum:

11. Access Control

12. CCTV Video Integration

13. Time and Attendance

14. Intruder Alarm Integration

15. Open SDK for HR Database Integration

16. Smart Phone applications to control system functions

17. Graphical Maps

18. Lift Control

19. Email/SMS Notifications

20. Emergency Lockdown

21. Mustering

22. Energy Management

23. Card Designer

24. Credential enrolment reader

25. Automatic User Image Display at PC on card use

26. Secondary door unlock control from fire alarm input

27. Various card reader technologies including clock & data, Wiegand and GSM

28. License free software and lifetime updates at no charge

29. Browser application for remote site management

30. Intercom / Video Entry Station

E. Building Integration

1. Providing that the necessary communication infrastructure exists, the system shall be capable of integrating multiple buildings within one collective access control/alarm monitoring entity whether the buildings are in relative proximity or at distant locations. The access control system's design shall further allow expansion or modification within existing buildings or the integration of new buildings at any time.

2. The system shall be structured to provide a continually expandable growth path from the capabilities and features specified within this document without the necessity of exchanging previously installed ACUs or software.

2.3 GENERAL REQUIREMENTS FOR SOFTWARE

A. Software

1. The system database containing all hardware and user information shall be held at the PC running the Server software.

2. The software shall feature:

   a. Multi-user and multi-tasking to allow for independent activities and monitoring occurring simultaneously at different workstations.

   b. A graphical user interface to show pull-down menus and a menu tree format that complies with interface guidelines of Microsoft Windows operating system.

3. System license shall be for the entire system and shall include capability for future additions that are within the indicated system size limits specified in this Section. There shall be no license fee or yearly renewal fees.

4. The system shall use open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows operating system.

5. Access shall be restricted using password-protected operator login.

B. Overall software capability

1. The software shall allow the configuration and control of hardware controlling the operation of doors, turnstiles, and other controllable devices.

2. The software shall monitor and report access control events of the entire ACS. It shall be possible to view these events at any number of workstations.

3. The software shall be capable of supporting at minimum 50,000 unique credentials and be able to manage and report on at minimum 1,000 access points.

C. The software shall provide the following as a minimum:

1. Access Control
2. CCTV Video Integration
3. Time and Attendance
4. Intruder Alarm Integration
5. Open SDK for HR Database Integration
6. Graphical Maps
7. Lift Control
8. Email/SMS Notifications
9. Emergency Lockdown
10. Roll Call and Mustering
11. Energy Management
12. Card Designer
13. Automatic User Image Display at PC on card use
14. Browser application for remote site management
15. Triggers and actions to achieve custom/unique functionality
16. Timesheet and timeline
17. Anti-passback
18. Customisable welcome page
19. Support for various card reader technologies, including clock & data, Wiegand and GSM
20. Support for Graphical Images on selected LCD Readers

21. Support for a credential enrolment reader

D. The Server and Client Graphical User Interface (GUI) shall be identical.

1. All configuration available at the Server shall be available at the Client.

E. The Server software shall create and maintain a single database for access-control and credential-creation functions.

F. Any change made to the database shall automatically be communicated to all intelligent access control hardware:

1. When hardware is online, updates shall be communicated with appropriate changes taking immediate effect.

2. When hardware is offline, updates shall be communicated when the hardware it is next online.

G. Distributed Processing:

1. The 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 in such manner that each Controller makes access-control decisions for that location.

2. Intermediate Controllers shall be unacceptable for access control.

3. If communications to Central Station are lost, all Controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Central Station.

H. System capacities:

1. The system shall support at minimum:

a. 1,000 controlled access points.

b. 50,000 users, each with a unique credential.

c. 2,000 input devices.

d. 2,000 controllable appliances.

e. 10,000 individual access levels.

f. 64 time schedules and 512 segments per time zone.

I. System Network Requirements

1. Client PCs shall communicate with the Server PC via TCP/IP on a LAN/WAN:

System events recorded by the Server shall be communicated to Clients.

Changes made to the database at a Client shall be communicated to the Server.

2. The Server PC shall communicate with access control hardware via TCP/IP on a LAN:

Access control events shall be communicated to the Server PC.

Changes to the database shall be communicated to the access control hardware.

3. The system shall utilise standard networking protocols to allow installation on corporate infrastructure.

4. No manual addressing shall be required.

2.4 APPLICATION SOFTWARE

A. The software shall use a familiar style user interface, enabling intuitive use.

B. The software shall be available in various languages to suit the installation and operator. Languages required at no additional cost include:

1. English
2. US English
3. Dutch
4. German
5. Spanish
6. Latin American Spanish
7. French
8. French Canadian
9. Japanese
10. Danish
11. Swedish
12. Portuguese

13. Italian
14. Arabic
15. Greek
16. Norwegian
17. Czech
18. Romanian
19. Turkish
20. Hungarian
21. Finnish
22. Serbian
23. Bulgarian
24. Polish

C. A SQL server database shall be used for the storage of user data and events.

D. The software shall be capable of importing and exporting all user data in .vcf, .csv and .txt formats.

E. The software shall be structured to support multiple workstations without extra license charges being levied.

F. Access permissions:

1. Access levels shall be used to administer the control of who is permitted through which access points and what times they are allowed through, on a minute by minute basis.
2. A minimum of 10,000 individual access levels shall be supported.
3. The system shall be able to give alternative access permissions to some or all staff, to accommodate flexible scheduling and holidays.

G. Reporting

1. User and system events shall be shown in real-time.

2. Reporting shall offer filtering options to allow for selection of all events, access events, alarm events and system events. Such event filtering and selection shall be customisable by time periods.

3. Reports shall be customisable. They shall allow for selection of date, time, users or user groups and access points.

4. Reports shall be configured within the access control user software and not a third-party application. A simple wizard shall be used to make configuring and saving reports as simple as possible for the user.

H. Users

1. The system shall be capable of supporting 50,000 unique token holder records.

2. The system shall be capable of supporting a minimum of 27 active tokens/credentials per user.

3. Tokens/credentials shall be able to be designated as lost and, if used, shall create a special event message.

4. The system shall be capable of setting a valid date range for each user. Outside of this date range any credentials for that user shall be recognised as invalid.

5. The system shall have a minimum of 16 definable user fields that can be tailored by the system administrator to store specific information.

6. The system shall allow users to be grouped into departments with validity dates and card templates. Departments shall be selectable when generating event reports and setting access permissions.

I. Operators

1. Any user may be given operator rights that allow them to log onto the software and administer the system.

2. A minimum of 50 operators shall be supported.

3. The system shall allow the restriction of operator privileges from certain areas of the software.

J. Access control alarms

1. The software shall be able to handle alarms at controlled appliances. At a minimum, the following alarms shall be supported:

   a. Door forced open

a. Door left open

b. Power supply failure

c. Hardware tamper

2. Each alarm event shall be reported in the event log. The system shall allow for alarm events to be acknowledged by an authorised operator.

3. The system shall support SMS texting email notification of alarm information.

4. When an alarm event occurs, an alarm shall sound local to the alarm source.

5. The action for alarms to sound shall be configurable in the software.

6. The time delay before sounding the alarm shall be configurable in the software.

2.5 SPECIFIC REQUIREMENTS FOR 'PRO' SOFTWARE

A. The Contractor shall provide a 'Professional' version of the software.

1. The manufacturer of the software shall provide updates and upgrades free of charge.

2. The software shall offer all features available in the 'Lite' software.

3. At minimum, the 'Pro' software shall provide in addition the following features:

B. Anti-passback

1. The software shall provide functionality of denying a user repeat access through the same access point within a specified time period. This shall prevent the same user's card being handed back to an unauthorised user for use.

2. It shall be possible to permit certain users to override the anti-passback rules.

3. Readers shall be required on both sides of any access point that is expected to employ anti-passback rules.

C. Time and attendance

1. The software shall be able to monitor time and attendance of staff, through use of dedicated 'clocking in' and 'clocking out' readers. The software shall be capable of operating with multiple 'clocking in' and clocking out' readers.

2. The software shall be able to cope with different hourly rates for staff and overtime rates such as 'time and a half'.

3. The software shall produce reports showing hours worked for users and departments over different date ranges.

4. The software shall support the importing of vacation and holiday schedules.

5. The software shall produce a report that shows total hours worked, remaining vacation time and holidays planned.

6. A graphical image shall be used in the software to display a user as clocked in, clocked out, holiday, vacation, out sick, off-site but working. Each setting shall support a customer defined colour to represent the location of user.

7. The time and attendance graphic shall be displayed by time of day/month for easy recognition.

8. The software can be segmented to display by person, department, or all users.

D. Roll call/muster

1. The software shall be able to generate a roll call report. This roll call report shall be able to be generated either manually using the software or automatically via a direct input from the fire alarm system.

2. The roll call report shall document User name, Department, Last known location, time of last access transaction and status (such as Safe or Missing).

3. Any reader on the system shall be able to be designated as a muster reader. Users shall present their token to a muster reader to be marked as 'Safe' on a report subsequently generated.

4. To use the roll call function, the controllers shall be required to be split into sections called “areas”.

E. Areas

1. The software shall have the ability to group doors together into defined areas. Once the system is split into areas, users given access into an area shall automatically be validated through all the doors of that area.

2. It shall be possible to collect several areas into an area group (for example, the areas of Reception, Factory and Cafeteria could comprise the area group of Main Building).

3. If a user is in one area the access attempt with that credential at another area shall be denied.

4. Unlimited areas can be defined with up to 50 doors per area.

F. Card Design & Printing

1. The card designer program shall allow unlimited configurations, with multiple templates saved for each user group. The ability to import company logo's and background images, overlay watermarks, static text fields and layers shall all be required components.

2. The software shall include a card designer application for the design of custom badges.

3. The designer shall support static text, shapes, and colours.

4. The designer shall support automatically generated text based on information entered into the user record.

5. The designer shall support the creation of single or double sided designs. Each design shall be labelled a template that can be entered into a user record.

6. All user defined fields shall be available for inclusion on the card design.

7. The software shall have the ability to print cards using a standard Windows card printer.

G. Intruder alarm

1. The 'Pro' version of software shall contain the same functionality as the 'Lite' version with at minimum the following additions:

2. The software shall support multi-zone / partition based alarm systems integrated so that a user's card can automatically arm/disarm the appropriate locations.

H. Lift control

1. An access control reader shall be able to call an elevator and, if necessary, take the user to their specific floor (denying access to unauthorised floors).

2. Integration shall be achieved by using a TCP/IP input/output module. The configuration of this feature shall be achieved using the software.

3. The software shall support the creation of departments or groups that are used in programming to simplify large quantities of people access rights to floors.

I. Energy Control

1. The ACS shall use an energy controller to be able to switch lighting on and off as required by the movement of users.

2. Integration shall be achieved by using a controller with a proximity reader designed to hold an ISO access credential. When the credential is inserted the output of the controller shall remain energised. When the credential is removed the output of the controller shall be turned off.

3. User control of the energy management function shall follow standard access level assignments.

2.6 SYSTEM HARDWARE FUNCTIONS AND COMMUNICATIONS

A. Features;

1. The ACU shall store locally the system database for faster and offline lookup.

2. The ACU shall be capable of making access control decisions.

3. The ACU shall allow the control and monitoring of a single access point.

4. The ACU shall be capable of supporting a combination of at least 4 of the following:

   a. Proximity readers

   b. Magstripe readers

   c. Keypads

   d. Combination reader/keypad.

5. The ACU shall support up to 50,000 unique card ID's

6. The ACU shall retain event data (at least 2,454 events per door) when there is no connection to the Server PC.

7. The ACU shall be able to automatically unlock doors during specified time periods.

8. All data shall be retained during a power loss.

9. Where time and attendance is used, the ACU shall be configurable to support a Clock In reader and Clock Out reader on a single door controller.

10. The ACU shall include support for tri-colour reader LED's control.

B. User interaction

1. Once installed, no further interaction with the hardware shall be required.

C. Display

1. The ACU shall have colour coding representation for reader, exit device, communications, and power connections to simplify installation, maintenance, and troubleshooting.

2. The unit shall include installation LED's to indicate the output relay status', TCP/IP communications status, network server connected status, input status and end of line termination status.

D. Communications

1. The ACU shall include TCP/IP interface for network communications directly into the processing board. Add-on modules are not approved.

2. In addition to TCP/IP, the ACU shall also include RS-485 communications for primary and/or secondary communications directly into the processing board.

3. The following data lines shall be supported:

   a. CAT5

   b. Belden 8723

4. The maximum cable length shall not exceed 1,000m (3,280').

5. It shall be possible to communicate with multiple ACU's over a single RS485 data line.

6. At minimum, 200 ACU's shall be supported per data line.

7. The ACU shall support the connection of readers:

   a. The ACU shall support the following reader input technologies simultaneously:

   b. Clock & data

   c. Wiegand.

8. The following cable types shall be supported:

   a. Belden 9540

9. The ACU shall automatically detect all connected peripherals.

E. Peripherals

1. The ACU shall provide at minimum the peripherals to support 2 readers or keypads.

2. The reader peripheral shall not be limited to a fixed data input, and instead shall accept data read from a variety of token types of different lengths, including but not limited to the following:

    a. PIN

    b. Code

    c. Token ID

3. The reader peripheral shall output current states relevant to the appliance to control for supplying feedback to the token holder in the form of an LED and speaker.

4. The reader peripheral shall provide the power that the reader requires to operate.

5. The peripheral shall provide:

    a. A voltage of 12V DC

6. The ACU shall support an LCD graphics image reader capable of controlling four stages of image display including:

    a. Image 1 for idle reader state

    b. Image 2 for access granted indication

    c. Image 3 for access denied indication

    d. Image 4 for personal identification code required indication

7. The ACU shall include an output for keypad readers that have a built in bell button that are used to activate an intercom, camera, or turn on siren/strobes.

8. It shall be possible to locate the reader at minimum 100m (328') from the door connector without communication becoming impaired.

9. The ACU shall automatically detect any readers/keypads.

10. The ACU shall house independent changeover relay channels.

11. The ACU shall provide at minimum 2 relays.

12. Each relay shall be provided with N.O. and N.C. contacts.

13. Relay contacts shall be voltage free.

14. Each relay shall be capable of switching a resistive load of at least 4A at 24V.

15. The ACU shall house a powered output for controlling locks.

16. The lock output shall provide at minimum 1A at 12V DC.

17. The ACU shall contain a tamper switch input.

18. The input shall be used to alert appropriate users in the case of unknown/impermissible access to the ACU.

19. The ACU shall contain a power supply unit (PSU) fail input.

20. The input shall be used to alert appropriate users in the case of a door lock power supply failing.

21. The ACU shall contain a door contact input.

22. The input shall be used to monitor the state of the door.

23. The ACU shall contain an input for an exit button or break glass.

24. The input shall allow exit buttons, break glass, and any other push-to-make contacts to input to the ACS for the purpose of unlocking an access point.

25. It shall be possible to connect multiple exit buttons in series to a single ACU.

26. Exit buttons shall be available from the manufacturer of the door connector.

27. The ACU shall include connections for an external intrusion alarm panel.

28. As a minimum, the ACU shall have a designated relay output, alarm condition status, and arming contact.

F. Power supply

1. It shall be possible to power the ACU with either of the following:

2. A PoE / PoE+ Power Supply Unit (PSU)

3. A 12V, 2A Power Supply Unit (PSU)

4. Maximum power usage shall not exceed 200mA at 24V DC.

G. Temperature

1. The ACU shall meet the required temperature standards for an internal product.

2. The ACU shall operate reliably within the temperature range of 0°C to 55°C (32°F to 131°F)

2.7 INPUT/OUTPUT BOARD(S)

A. Features

1. The ACS shall include support for input/output boards designed to monitor auxiliary inputs and provide relay outputs for control of external devices.
2. The I/O board shall support a minimum of 4 inputs and 4 outputs.
3. It shall be possible to use input states to trigger events in the ACS via Triggers and Actions.
4. It shall be possible to control relay outputs via Triggers and Actions.
5. Detachable terminals for quick and hassle free maintenance.
6. Fault finding LEDs.
7. Quick and intuitive installation.

B. Power supply

1. The I/O board shall be powered from a 12V, 2A Power Supply Unit (PSU)
2. Power usage shall not exceed 400mA when all relays are energised.

C. Display

1. Peripherals shall be labelled clearly and intuitively.
2. The item shall house LEDs for fault finding.
3. An LED shall indicate when the item is powered.

D. Communications

1. The I/O board shall include TCP/IP interface for network communications directly into the processing board via an RJ45 connector. Add-on modules are not approved.

E. Peripherals

1. The I/O board shall house 4 independently controllable relays.
2. Each relay shall be provided with COM, N.O. and N.C. contacts.
3. Relay contacts shall be voltage free.
4. Each relay shall be capable of switching a resistive load of at least:

a. 13A @ 240V AC

5. Each relay shall be capable of switching inductive loads.
6. Each relay shall have a contact isolation of at least 4KV AC
7. Each relay shall retain its state when the I/O connector losses power.
8. The relay functionality shall be configurable in the access control software provided with the ACS.
9. The I/O board shall house 4 digital inputs.
10. Each input shall be formed of 2 terminals.
11. Each input shall be configurable to trigger a Trigger and Action rule to perform pre-defined tasks.

F. Temperature

1. The item shall operate reliably within the temperature range of -20°C to 55°C (-4°F to 131°F)

2.8 POWER SUPPLY UNIT (PSU)

A. Features

1. PSU voltage shall be correct for all ACS hardware requiring an external DC power source.
2. Output voltage shall be 12V DC (+/- 10%)
3. Output current ripple shall not exceed 100mV
4. The PSU shall be capable of providing at minimum 2A.
5. The PSU shall be capable of powering at least 3 individual devices at 12V each.
6. Maximum cable length shall be at least 2m (6.6').
7. The PSU shall allow connection to a 12V / 7Ah backup battery.
8. The PSU shall trickle charge the connected battery to keep it continuously charged at maximum capacity.

B. Power supply

1. The PSU shall operate from Mains supply, supporting the following:

b. 100V to 240V

c. 50 to 60 Hz AC

C. Display

1. Peripherals shall be labelled clearly and intuitively.

2. An LED shall indicate when the item is powered by Mains supply.

3. This LED shall be green to indicate that the item is working correctly.

4. An LED shall indicate when the item is powered by battery backup.

This LED shall be red to indicate that the supply has failed.

D. Peripherals

1. The PSU shall house 3 independent 12V connections.

2. The PSU shall house a power supply fail output.

3. This shall be a pair of voltage free contacts that shall go open circuit is the mains power fails.

E. Temperature

1. The item shall operate reliably within the temperature range of -20°C to 44°C (-4°F to 111.2°F)

2.9 ACCESS CONTROL SYSTEM SERVER, WORKSTATION AND CONTROL PANEL SPECIFICATIONS

A. Minimum Server Hardware Requirements to operate Paxton Access Control Software;

1. System software requirements shall be based on independent, intelligent devices that are interconnected and communicate to a PC/Windows® compatible computer with the following Paxton minimum recommended specifications:

a. Recommended Central Processing Unit: Intel Pentium Dual Core 2.2 GHz or higher; Intel Core Duo 2.6 GHz or higher (Celeron and AMD not recommended)

b. Recommended RAM: 2 gigabyte or greater

c. Hard Drive capacity – recommended 100 gigabytes of available disk space

d. USB Port for Photo Badging or Signature Capture

e. COM Port: 1 required if using direct serial connection to access control units; 2 required if using CCTV control as well

f. CD-ROM or DVD drive

g. Mouse or compatible pointing device

h. Removable Media Storage Device such as CD/DVD Writer for database backup

i. Gigabit Network Interface Card (NIC) with TCP/IP protocol with a valid, active IP address (SQL Server 2005 Express PC must be assigned a static IP address) and file & printer sharing for Microsoft networks

j. Graphics card that supports 1024 x 768 or higher screen resolution

k. Operating System: Windows 8 (32 bit or 64 bit) – Professional & Enterprise versions, Windows 2012 Server (64 bit/graphical user interface enabled) – Standard version, Vista Business, Windows 7 – Professional, Enterprise or Ultimate versions, Windows 2003 Server, or Windows 2008 Server (supported Windows operating systems – 32 bit)

l. Microsoft Internet Explorer 6.0 Service Pack 1 or later

m. Microsoft .NET Framework 3.5 required for Windows 8 or Windows 2012 Server

n. Microsoft .NET 2.0 Framework for all other supported operating systems

o. Virtual Server (Supports virtual machine server topology providing that all licensed and required Paxton software applications are allocated sufficient server resources for proper system performance and that the VM software/server is supported by qualified IT personnel.)

B. Access Control Server shall be (xAccess100) XVault Access Control Appliance from Seneca Data. No substitutions permitted.

1. Access Control Server form factor shall be rackmount.

2. Provide the following options: 1TB Solid State Drive, 4GB DDR3 1600MHz RAM Memory, DVDRW Optical Drive and one GB LAN port.

3. Security Contractor shall provide the 3 year, Next Day, On-Site Warranty for all access control servers provided for this project.

C. Workstation Specifications

1. Workstation shall be shared with Video Surveillance System. Refer to Specification 28 23 00 Video Surveillance for the Workstation requirements.

D. Access Control Panel Physical Configuration

1. The Access Control Panel shall be a fully engineered assembly for each location where they are indicated in the Design Drawings. All enclosures shall be equipped with key locks. Turn over all keys at Final Acceptance.

   a. Dedicated wall space is given for ACP' s in TR Rooms, and may not be sufficient if the ACP is large enough and may encroach on other equipment.

   b. At the MDF/Head End ACP, provide enough room for As Built drawing storage as part of this ACP assembly. Refer to Section 3.4 ASBUILTS for further details. Contractor to include method to store As built drawings in the dimensioned Wall Elevation.

   c. Clarification of Telecom Room space requirements shall be provided in the ACP Wall Elevation drawing.

   d. Provide one dimensioned drawing for every ACP in the project.

2. Refer to Section 1.6 SUBMITTALS for further details.

3. The ACP assembly is an inter-connected group of components consisting of but not limited to the following devices which may require more than one enclosure, and shall consist of, but is not limited to, the following connections and equipment;

   a. Access Control Panel key lockable metal enclosure(s) as provided by the manufacturer. An alternate of a single large key lockable enclosure is acceptable if properly sized to enclose all of the below components and has suitable ventilation.

   b. Input/output boards, network/communications, media converters, Ethernet extenders, misc. relays.

   c. Battery key lockable enclosure(s).

   d. Sealed Lead Acid (SLA) batteries, by Power Sonic, sized for the application and connected load, plus 20% spare capacity. All Low Battery and AC Loss connections shall be tied into the system for monitoring.

   e. Power supply key lockable enclosure(s).

   f. Wire/cable management in the form of plastic, slotted wiring duct with hinged cover. All wiring shall be concealed in the wiring duct or conduit. No wiring shall be exposed. Wiring duct shall be from Panduit, in white or grey with hinged cover, sized properly to house all the cables within it.

   g. Velcro cable management only, no zip ties are permitted within the ACP assembly anywhere except as noted below for the class 2 plug in transformers.

h. Wire/cable labels, shall be placed in proper locations at ends of cables, with lettering visible, with permanent ink generated by a computer, no hand written labeling permitted.

i. Junction boxes for Fire Alarm connections.

j. Junction boxes for Facility Power connections.

k. Lightning and surge protection devices from Ditek Corporation. Contractor shall select the device for the application and include it in all required project documentation for approval. Devices shall be installed in approved locations only.

4. Wall mounted transformer spaced outlet power strip, from Tripp Lite, # PS 2408, with metal enclosure.

5. Mount horizontally in such a way that class 2 plug in transformer power input prongs are at the top, permitting the transformer to "hang".

   a. Provide ¼" spacers behind the power strip to permit plastic zip ties to secure the transformer to the power strip.

   b. Clearly label all transformers to identify purpose and use.

   c. Provide wire duct immediately adjacent to transformer outputs to conceal all cabling.

   d. Locate this sub-assembly at the bottom of ACP.

6. Electrical Metallic Tubing (EMT) conduit and/or, Flexible Metallic Tubing (Greenfield).

E. Access Control Panel Functions and Capabilities

1. The system shall be comprised of access control unit(s) to regulate and monitor door access and monitor inputs and/or elevator control units to regulate and monitor elevator floor access.

2. Access control units shall have dual on-board processors for robust performance such that during uploading and downloading of data the system operates at peak efficiencies.

3. All ACUs shall have fully distributed and fully intelligent data processing and shall be capable of rendering all decisions independently. Further, if the system goes off-line, the ACUs will continue to function at 100% operability without resorting to a de-graded mode of operation. Database information required for full functioning of each reader shall be distributed to reside in the non-volatile memory of the ACU. The

control unit shall store proprietary software and program logic in read only memory (PROM). Access control units shall be capable of storing all cardholder records.

4. Access control units shall be capable of retaining in memory the last six thousand (6,000) events that occurred during the off line mode. If ACU communication is disrupted with the database, when communication is restored, those transactions shall be transmitted to the computer with the database.

5. The control unit shall function with direct communication to a PC. When using more than 1 PC, the ACU shall use a separate communication board per ACU.

6. The access control units shall be capable of accepting other Wiegand protocols by the adjustment of jumper settings on the circuit boards.

7. The control board shall have system and communication LEDs. The LEDs shall be readily identified and visible providing technicians with a valuable diagnostics resource when installing and servicing the controller.

8. The door control boards and the elevator control boards shall be available in the following configurations. The door control units may be installed on a "mix and match" basis for optimum configuration.

9. Door control boards – 1, 2, 4, & 8 portal configurations

   a. The door control board with the single (1) portal configuration shall have the following additional features:

   b. Has a built-in on-board Ethernet module (IEEE 802.3af) configurable for encrypted and non-encrypted communication.

   c. Capable of operating with Power over Ethernet (PoE) via the on-board Ethernet module (680 mA @ 12 VDC) or from an independent 12 DVC power supply.

   d. Supports DHCP

10. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

11. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

12. Refer to the Block Riser Drawings for cable and wire types used for various devices.

13. For wire and cable installation requirements, refer to the wire and cable section for details.

2.10 FIELD DEVICES

A. Card Readers

1. Card Readers shall be HID multiCLASS SE series, dual technology readers, model RP40, switch mount type or mullion mount models RP15 or RP10.

2. Credential reader shall be capable of dual frequency reads at 125 KHz and 13.56 MHz.

3. All outdoor readers shall be equipped with lightning and surge protection devices from Ditek Corporation. Contractor shall select the device for the application and include it in all required project documentation for approval. Devices shall be installed in approved locations only.

4. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

5. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

6. Refer to the Block Riser Drawings for cable and wire types used for various devices.

7. For wire and cable installation requirements, refer to the wire and cable section for details.

B. Credentials – Key Fobs

1. Dual technology key fobs have 125 KHz proximity and 13.56 MHz frequency Smartcard capability. These fobs may be provided by others for use on the Dorm Space locks and on the perimeter access control system and shall be compatible with Proximity and iCLASS type dual technology readers.

2. The Security Contractor shall coordinate with Division 8 for these fobs and is responsible for the programming and testing of dual technology key-fobs provided by others.

C. Door Contacts

1. Door alarm contacts shall be GE/Sentrol 1076 or 1076D.

2. Door Contacts may be internal of electrified door locking hardware when a power transfer hinge is specified.

3. Color of contact shall match the door frame finish as closely as possible.

4. The contact and magnet housing shall snap-lock into a 1" diameter hole. The contact shall be SPST, where indicated on the Design Drawings. DPDT type shall be indicated where needed.

5. All contacts and inputs to the ACP shall be on a "supervised" circuit. An end of line resistor shall be installed at the alarm contact location and not at the control panel location.

6. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

7. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

8. Refer to the Block Riser Drawings for cable and wire types used for various devices.

9. For wire and cable installation requirements, refer to the wire and cable section for details.

D. Overhead Door Contact/Roof Hatch Contact

1. Surface mounted contacts shall be GE Security 2204 overhead door contact.

2. Furnish and install alarm contacts at the floor for roll up type doors and/or hatches that require wide gap surface mounted contacts.

3. The contact shall be loop type, open or closed, SPDT, 3" gap distance, with 18" flexible stainless steel cable housing.

4. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

5. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

6. Refer to the Block Riser Drawings for cable and wire types used for various devices.

7. For wire and cable installation requirements, refer to the wire and cable section for details.

E. Request to Exit Device

1. Request to exit PIR type motion sensor shall be Allegion/Schlage SCAN II or Bosch DS160 with 1 gang trim plate.

2. Wherever possible, request-to-exit (REX) functionality should be integrated into the electrified locking hardware.

3. Where an integrated solution for request to exit is not provided or provisioned by the selected locking hardware, furnish and install a PIR type motion detector designed for request to exit applications at all locations as indicated on the Design Drawings.

4. Some doors will be monitored for door position only and may not have a reader and REX device.

5. Power input shall be 12-30 V DC/AC

6. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

7. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

8. Refer to the Block Riser Drawings for cable and wire types used for various devices.

9. For wire and cable installation requirements, refer to the wire and cable section for details.

F. Electrified Locking Door Hardware

1. Door Hardware shall be specified by the Architect and is provided and installed by the locking hardware Contractor.

2. Refer to the Architectural Door Hardware list, Index, and Door Hardware Specifications for further details.

3. Fire Rated, Panic Hardware, Electric Strikes and Magnetic locks shall be installed and wired as per manufacturer recommendations, local and other Codes, and the Authority Having Jurisdiction per door, for all doors.

4. The Security Contractor shall coordinate with all other trades and stakeholders as required to ensure complete and proper installation and deliver a fully functional door(s) controlled or monitored by the Access Control system.

5. Security Contractor to test all functions at all access controlled doors.

6. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

7. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

8. Refer to the Block Riser Drawings for cable and wire types used for various devices.

9. For wire and cable installation requirements, refer to the wire and cable section for details.

G. Power Supplies and Locking Hardware Power Supplies

1. Access Control peripheral devices shall be powered by Altronix, SDC, Allegion brands, or Assa Abloy brands power supplies. All power supplies shall be UL Listed.

2. Install 24VDC power supplies to power all electrically controlled door locks as required.

3. It is the responsibility of the Security Integrator to coordinate facility power requirements with the project electrical contractor for power connections where needed and Fire Alarm connections where needed.

4. Size all power supplies to permit simultaneous continuous-duty activation of all door locks, with an additional minimum 20% capacity on each supply. Calculate voltage drop to locks and size lock control wiring to provide proper lock operation.

5. Run individual lock power circuits from a separate fused output on Power Distribution Modules, located within the access control panel.

6. All Low Battery and AC Loss connections shall be terminated into the system for monitoring.

7. Provide Sealed Lead Acid (SLA) battery back-up sufficient for 4 hours standby plus 25 activations for all DC locks.

8. Provide a separate enclosure for the batteries if the batteries will not fit securely in power supply enclosure "right-side-up". Do not lay batteries on their sides or ends in order to fit them into the enclosure. Do not expose wiring between the power supplies and the batteries.

9. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

10. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

11. Refer to the Block Riser Drawings for cable and wire types used for various devices.

12. For wire and cable installation requirements, refer to the wire and cable section for details.

H. Fire Alarm Interface connection

1. Provide as required per the current code (NFPA 72), a connection from the access control system to the Fire Alarm system to respond to this input of an emergency condition as per all local and national codes, ordinances, statutes and/or rules, guidelines and directives of the governing local Authority Having Jurisdiction.

2. Access Control shall provide, as per code, a door unlock function to unlock all doors that require this action when an active, authorized alarm signal is activated, or by

direct interruption of the lock power circuit for doors in the path of egress equipped with access control and electrified door hardware.

3. Fire Alarm interface connection shall comply with NFPA 70, 72 and National Electrical Code requirements.

4. All Fire Alarm connections shall be included in the Shop Drawing package for review, and in the As Built Drawing set.

I. Local Door Alarm

1. Provide door management alarms for local and remote monitoring and annunciation of the status of the doors (door prop/door held, door intrusion/door forced or secure) as indicated on the Security Device Drawings.

2. The LDA shall be capable of operating in a "stand-alone" configuration or with an access control system, utilizing all reader technologies: i.e. proximity, weigand, mag stripe, bar code or biometrics.

3. Local sounder (field selectable volume 96 or 103 dB @ 3 feet) shall be used to indicate both door prop/door held and intrusion/door forced conditions after a user selectable quiet, or access, time (0 seconds to 90 minutes) has expired. Sounder shall be incorporated into the faceplate of the LDA.

4. Form C (N/O and N/C) contacts shall be available for the following outputs: Door Contact Status, Door Prop Alarm, Intrusion/Tamper Alarm and Bypass/Key Switch Status.

5. The alarm (intrusion) contact shall change state upon the recognition of an alarm or tamper condition to alert remote monitoring equipment.

6. The unit shall remain in alarm until reset by integral key switch, remotely through a dry contact or automatically through an onboard timer (user settable from 0 seconds to 5 minutes or MANUAL).

7. An integral key switch shall be available for alarm shunt or alarm reset and be incorporated into the faceplate of the LDA.

8. A Bi-Color status LED shall be incorporated into the faceplate of the LDA.

9. A remote LED output shall be provided to control a bi-color LED that follows the actions of the faceplate mounted LED.

10. Inputs shall include a N/C Dry Contact for the door, Voltage Sense (12-24 VAC/DC) to monitor electric lock voltages and a N/O or N/C Dry Contact Shunt Input.

11. The following timers shall be user settable: Auto-reset, Alarm delay, Silent time and Shunt Delay.

12. The LDA shall be mounted in the wall adjacent to the monitored door at 42" above finished floor. The unit shall mount in a standard 2 gang (3 gang for rim cylinder key switch model) electrical box with a minimum depth of 2 ½".

13. Refer to Architectural Door Hardware List, Specifications and Design Drawings for further details.

14. Refer to Door Detail drawings which indicate infrastructure rough in details for conduit and back boxes.

15. Refer to the Block Riser Drawings for cable and wire types used for various devices.

16. For wire and cable installation requirements, refer to the wire and cable section for details.

17. The LDA shall be Designed Security, Inc. Model ES4200-K1-T1, or Kouba Systems LDA9602.

J. Duress Button

1. Under counter/desk door release with momentary pushbutton, surface mount, black abs plastic box with two mounting ears.

2. S.P.D.T. contacts, rated 4 amps @ 28 VDC.

3. UL Listed and C.S.A. certified components.

4. Duress button shall be from Alarm Controls, Model TS-18.

K. Ethernet Media Converters

1. Media Converters can be deployed to convert a signal to travel on Ethernet compatible media/cable where needed. Many types and applications are available for use and shall be acceptable from Network Video Technologies or Comnet.

2. Security Contractor shall select devices for use and submit Data Sheets for approval of all devices and shall show them in the Shop Drawing package where used at all locations.

L. Ethernet Extenders

1. Any camera or IP device that will have a cabling length of more than 300 feet will require and Ethernet extender.

2. Ethernet extenders shall be placed in approved locations when used. Devices shall not be hidden in locations that cannot be easily access or maintained with certain ease.

3. Security Contractor shall select the devices for use and submit Data Sheets for approval of all devices and shall show them in the Shop Drawing package where used at all locations.

4. Devices from Veracity Outreach Max family of products shall be approved, no substitutions permitted.

M. Lightning and Surge Protection

1. All outdoor equipment shall have UL Listed lightning and surge protection devices from Ditek Corporation.

2. Contractor shall select the device for the application and include it in all required project documentation for approval.

3. Devices shall be installed in approved locations only.

2.11 WIRE AND CABLE

A. Cabling shall be West Penn, Belden, Mohawk, Windy City or SmartWire.

B. All cabling shall be plenum (CMP) rated.

C. All Cables shall be U.L. Listed, and appropriate for the application.

D. Contractor shall be responsible for providing proper cable supports where conduit, cable trays and/or cable paths are not provided. (Rods and J-Hooks) Cable will be run free air above ceiling areas with plenum rated cable. Firewall penetrations must be coordinated with the General Contractor.

E. Contractor shall follow the manufacturer's recommendation for cabling. Wire and Cable sizes, number of conductors, shielding, or other data listed in this specification or shown on Drawings are a guide to the correct product required to achieve a working system and represent minimum acceptable equipment. Cabling shall be sized and installed according to local electrical code requirements.

F. Wire splices are not permitted in any circuit. If a splice cannot be avoided, the splice work shall be submitted for review and approval prior to installation of cable run affected. The submittals shall include the following details; the reason for the splice, a detailed drawing of the splice, all wire types involved, termination details, physical protection, and protection from the elements must be submitted.

G. All Cable shall be run in unbroken lengths of 1000 feet or less. When Cable cannot be run in unbroken lengths due to Cable spool limitations over 1000 feet, splices shall be made in junction boxes with terminal blocks or terminal strips and fork spade lugs. All splices and junction boxes shall be clearly marked on the final drawings.

H. Cables are to be shielded as necessary with drain wires properly terminated and grounded. Use proper grounding practices to eliminate ground loops, and terminate drain wires as factory recommends to prevent unwanted voltages and electrical noise from degrading system performance.

I. Contractor shall utilize existing pathways, conduit and cable trays were applicable. Any cabling or raceway exposed to weather shall be rated for that use.

J. All 12 or 24VDC power cabling shall be of stranded construction. For connections requiring pressure captive connection, wire shall be tinned prior to insertion into pressure connectors.

K. All Cable shall be labeled at origin and termination, referencing to a master legend schedule as shown on submittal Drawings.

1. Labeling and any splice locations shall be noted on as-built Drawings.

2. All Labels shall be done using machine generated cable tags in the "flagged" position.

3. Hand written labels are not acceptable.

L. Wiring shall be grouped and harnessed to facilitate access to all equipment, as well as maintenance and replacement of equipment.

M. Use of Velcro cable management is specified. Use of tie wraps/zip ties for cable bundle management is not permitted.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Systems shall be complete and operational in all respects.

B. The Contractor shall furnish and install all equipment necessary to build the Integrated Security System as referenced herein

C. All wall, floor, and ceiling penetrations, regardless of fire rating, must be properly sleeved with conduit and properly sealed using approved fire stopping materials and sealants, according to CCC standards.

D. All security equipment, junction boxes, terminal cans, etc. installed in public accessible areas shall be installed utilizing tamper proof mounting hardware. Contractor shall provide a minimum of 2 driver bits or hand tools for each type and size of security fastener provided.

E. The Security Contractor shall provide seismic restraint for all equipment, including equipment racks, consoles, etc.

3.2 ACCEPTABLE INSTALLERS

A. Contractor shall be a factory authorized representative of the Access Control System equipment they intend to provide and shall present a copy of their certificate designating them as a factory authorized distributor/installer. Contractor shall have a proven installation and service/maintenance track record with all Access Control components they intend to provide.

B. Skilled technicians are to perform all commissioning, programming and testing and are, at a minimum, to be factory trained and certified to work with the Access Control System components and equipment.

C. Local branch office personnel directly employed by the Contractor shall perform all work including, but not limited to, engineering, design, checkout, startup, programming and pre-testing and final acceptance testing.

3.3 FACILITY POWER TO SECURITY EQUIPMENT

A. Power all equipment from 120 VAC circuit dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded "Security Equipment - Do Not Operate", or equivalent.

B. All plug-in transformers shall be located at the security control panels.

3.4 GROUNDING

A. Provide earth-grounding of equipment as required by equipment manufacturer. Earth ground shall be connected to ground rod or approved cold water pipe. Electrical or telephone ground connections shall not be used as earth grounds. Connections to mounting posts or building structural steel shall not be used as earth grounds.

3.5 PROGRAMMING

A. Contractor shall provide initial programming for all applicable systems. Contractor programming shall include, but not be limited to:

1. English-language description of each alarm location.

2. Programming of the head-end equipment.

3. Programming of Access Control Software.

4. Integration to the Video surveillance system.

B. The Contractor shall submit to CCC for the review, prior to work being initiated, the proposed programming, including device names and descriptions, timings, sequence of operations, etc.

C. Upon CCC's request, the Contractor shall reprogram each system one time during the Warranty Period at no additional cost. At no additional charge, the Contractor shall update the system software to the most recent version available at the time of the reprogram.

3.6 TESTS AND REPORTS

A. The Contractor shall perform system tests using personnel who have attended a manufacturer's training school for installation and testing of the systems as described herein. The Contractor shall perform testing with the test instruments as specified/directed by the manufacturer.

B. Testing by means other than the manufacturer's procedures will not be acceptable unless agreed to in advance in writing by CCC, Security Consultant and the equipment manufacturer.

C. Upon completion of the installation of the Security Systems, the Contractor shall submit written reports including, but not limited to, the following information:

1. A complete list of all equipment installed, including serial numbers of major components.

2. Certification that all equipment is properly installed, programmed, functional, 100% operational, and in conformance with contract Specifications and Drawings.

3. Test reports of all access control system cable infrastructure, tested devices, and equipment operation to indicate the system is substantially complete and ready for demonstration.

4. Test technician's name, company and date of test.

D. Following review of the test report(s) by CCC, the Contractor shall perform a test of Security System equipment in the presence of CCC and the Consultant. Test(s) shall include performance tests of all equipment and material required by the contract. The Contractor shall be responsible for all additional costs to CCC if retesting is required. At a minimum, perform tests to demonstrate that:

1. All systems operate normally and are free from grounding problems and open circuits.

2. Systems operate properly on standby power/ battery backup.

3. All software functions properly as specified, and all equipment is fully programmed.

E. Sixty days prior to expiration of Warranty, Contractor shall retest all systems as described herein, and submit a test report of findings. All items covered by Warranty shall be corrected immediately. The Warranty shall remain in effect until the Contractor corrects 100% of defective items.

3.7 AS-BUILT DRAWINGS

A. The Contractor shall maintain a complete set of CCC Approved Shop Drawings on-site as the work on the Access Control System is being completed. As work is installed, Contractor shall record all installation details and correct location of work including all critical dimensions.

B. Upon completion of the project, Contractor shall provide all as built information as CAD Drawings (.dwg), and submit to CCC for review. No hand-drawn as-built drawings shall be accepted.

C. The Contractor shall provide four (4) sets of As-built Drawings, plus one (1) set of CAD disks, to CCC. One (1) additional complete set shall remain on the job site secured on the wall adjacent to the control panels at the head end.

D. Turn over all keys to equipment cabinets, spare fuses, tools for tamper proof hardware and manually resetting devices.

3.8 TRAINING AND OPERATION/MAINTENANCE MANUALS

A. The Contractor shall provide a minimum of four (4) copies of Operation and Maintenance manuals for all equipment furnished under the Security Systems sub-sections. These manuals are to be available for training.

B. The Operation and Maintenance manuals shall include the following information and full procedures for;

1. Database back-ups.

2. Server/workstation hard drive maintenance, such as defrag, drive and RAM memory replacement, etc.

3. Maintaining physical and software firewalls.

4. Upgrading any software used in the system.

5. Testing battery condition on all field panels for adequate back-up time.

6. Any other tasks that must be performed to ensure the warranty remains intact.

C. Provide a minimum of eight (8) hours of scheduled training for the equipment furnished under this Section, including programming, operation, service, and maintenance.

D. Training shall be by engineers or technicians highly skilled in the systems and certified by manufacturer as qualified to train in the particular systems.

E. Training shall be conducted at dates and times directed by the CCC's representative. Training shall be provided for all security staff personnel and system end-users.

F. CCC, prior to release of retention compensation, shall require verification of completion of training.

3.9 CCC IT REQUIREMENTS

A. The Security Contractor shall coordinate with the CCC IT department (IT) for all network and telecom connections to keep within the level and consistency of workmanship quality, materials selection and installation methods for all work performed in any Telecommunications Room (TR). Security Contractor shall request an IP address table from the CCC IT department (IT) for all devices requiring an IP address. The address table must be approved prior to deploying and programming devices and a Report submitted for review at demonstration of Final Acceptance.

END OF SECTION

SECTION 28 23 00 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide all materials, hardware, software, fabrication, coordination and installation, programming, testing, documentation, and training in conformity with manufacturers' documentation, the specifications contained herein, all applicable Codes and authorities having jurisdiction for the implementation of a complete Video Surveillance System (VSS). Refer to Scope of Work section within this specification for further details.

B. The Security Contractor shall be responsible for coordination of all VSS system related installation issues with any and all stakeholders, CCC IT Department, and other trades. This includes programming of all software and hardware, connections/interfaces. Coordination of conduit/pathways, and power requirements for security devices directly with electrical contractor when necessary to complete installation. Refer to Scope of Work section within this specification for further details.

1.2 PROJECT SCOPE

A. The Contractor shall be responsible for fully implementing the functions described in the specifications and shown on the Design Drawings and Specification Documents, which may not show or list every item required or to be provided. When an item not shown or listed is clearly necessary for proper installation and operation of equipment or the system(s), the contractor shall provide this equipment, components, or software at no additional cost to the Owner.

B. Provide and submit all required documentation as a single submission at the beginning of the project as outlined in the Submittals section.

C. A Complete turnkey integrated (to Access Control) Video Surveillance system is defined as all fiber optic switches, edge switches, SFP/GBIC modules, fiber optic patch cords, Category 6 patch cords for connection to the dedicated security network provided under this specification section, all software, VMS application, all licenses for the VMS and cameras, recording storage servers/appliances, workstation(s) 4 port KVM, slide out/lift up 1080p display/keyboard console, 2U rack shelf, cameras, camera ceiling installation kits, camera outdoor housing assemblies, encoders, power supplies, etc., as well as all cabling/wiring not provided by others as referenced herein, provide all programming and make all adjustments, system test, checkout and commissioning, provide all Shop Drawings and Data Sheet Submittals, Close Out Submittals, including Test Reports, Operation and Maintenance Manuals, Training Classes and materials, As built or Record Drawings, and certify (submit Warranty Certificate) the entire integrated access control/video surveillance system solution needed to achieve a complete and functional system, as basis of the Contract Price.

D. The Integrated Access Control and Video Surveillance System shall communicate using the existing fiber optic network provided and installed by the Communications contractor. Refer to Section 2.020 Dedicated Security Network Section in this specification for additional information.

E. The (VSS) shall be a complete system provided with Remote Viewing and Mobile Device viewing capabilities as part of the video management system for this project.

F. The system design includes new IT Rack mounted equipment including a mid-tower workstation, desktop KVM switch, slide out/lift up 17" LCD 1080p display with keyboard, network switches and video recording server with accessories, video, control/USB cabling, interconnect and 2U rackshelf.

G. The Security Contractor shall coordinate all his work and work in harmony with other trades on the project as well as with A/E personnel and contractors performing work under a separate contract where all work is contributing to the overall project. Cooperate fully with the Architect or his agents so work may be carried out smoothly, without interfering with or delaying work under this contract or work by Architect. This would include timely submission of documents and/or notices of impending scheduled events or milestones where others are required to attend or participate in reviews, site walks, testing, commissioning and demonstration for Final Acceptance with the A/E personnel.

1.3 RELATED SECTIONS

A. 28 13 00 Access Control

1.4 REFERENCES

A. Each agency's relative codes, standards, and recommended practices apply to the Access Control System and its components as specified herein.

B. Published specifications, standards, tests, codes, or recommended standards of trade, industry, or governmental organizations apply to work in these Sections, including:

1. ADA - Americans with Disabilities Act
2. ASCII - American Standard Code for Information Interchange
3. ASTM - American Society for Testing and Materials
4. EIA – Electronic Industry Association
5. NEMA - National Electrical Manufacturers' Association
6. NFPA - National Fire Protection Association
7. NEC - National Electrical Code
8. UL - Underwriters Laboratories, Inc.
9. ASIS – American Society for Industrial Security

10. FCC – Federal Communications Commission

11. OSHA – Occupational Safety and Health Administration

12. IEEE – Institute of Electrical and Electronic Engineers

13. ANSI – American National Standards Institute

14. State and Local Fire Marshal

C. Electronic devices radiating "RE" energy shall comply with Federal Communication Commission regulations, particularly Part 15, and shall meet minimum Class "B" requirements. Provide FCC certificate numbers indicating that the FCC has approved products.

D. Where any of the above standards or codes differs with the contract documents and specification, the more stringent requirements shall take precedence. Any cost necessary to meet any AHJ requirements shall be included in the Contractor's price.

1.5 QUALITY ASSURANCE

A. Contractor and any Subcontractors shall be responsible for and familiar with all city, county, state, and federal codes, rules, ordinance, and regulations of the AHJ and their interpretations, which are in effect for these Premises.

B. The latest issue of all recognized codes, standards, and recommended practices of the following agencies in effect on the date of award of a contract shall form a part of this specification.

C. A nationally recognized test laboratory shall list all equipment supplied where applicable.

D. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

E. All items of a given type shall be the products of the same manufacturer.

F. All items shall be new and of the latest technology and version-level; no discontinued models or products are acceptable.

G. No Beta products will be accepted.

H. The manufacturer, or their Authorized Representative, shall confirm that within 100 miles of the project site there is an established agency which:

1. Provides a full Service Operation and stocks a full complement of replacement parts.

2. Offers service during normal working hours as well as emergency service on all equipment to be furnished.

3. Will supply parts and service without delay and at reasonable cost.

I. The Contractor shall be a factory authorized representative of Milestone Systems, licensed to sell, install, and maintain all system, subsystems, components, and software required in the United States, and shall present a copy of their certificate designating them as a factory authorized distributor/installer.

J. The Contractor shall have at least five (5) years' experience designing, selling, installing and maintaining the VMS/VSS equipment being bid, and shall possess all applicable Contractor licenses.

K. Skilled technicians are to perform all installation, commissioning, programming and testing and are, at a minimum, to be factory trained and certified to work with the video surveillance system.

L. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.

M. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.

N. All software provided shall be the latest version available by the manufacturer upon final acceptance of the system. This includes Microsoft products contained as part of the system. All of the latest updates and patches shall be installed at the time of acceptance.

O. The Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

1.6 SUBMITTALS

A. Provide the following Data Sheets, NVR Storage Calculations and Shop Drawing package documentation as a complete submission to ACC at the start of the project.

1. Provide a complete Bill of Materials with quantities of equipment supplied.

2. Data Sheet submittals indicating manufacturers name, model number, and a full description of the component and UL Listing for all equipment supplied.

   a. Provide a Data Sheet for every item listed in the Bill of Material.

   b. Indicate or high light all model numbers of equipment to be reviewed prior to submission for approval.

3. Provide NVR Storage Calculations – NVR shall record only alarm events. To size the NVR hard disk size, submit a report or screen shot of the camera or NVR manufacturer's website for video storage calculation. Motion detected alarm events will be recorded at 30 frames per second with 2 minutes pre- and post-alarm event, and saved as a "Clip" to the NVR. Alarm clips older than 30 days can be overwritten or programmed to be deleted to make room for newer alarm clips. Camera recording stream profile for all camera/NVR storage calculations is based on;

   a. All cameras indicated on the Design Drawings.

   b. 30 days' retention.

c. 30% motion detection.

d. Native resolution of the given camera.

e. 30 frames per second.

f. Variable bit rate.

g. H.264 compression.

h. Plus 20% spare capacity.

4. Shop Drawing package shall be submitted and is the foundation of the As Built drawing package, and shall include the following details;

   a. Provide dimensioned elevations and details for every console, rack, and fabricated equipment being supplied under this section.

   b. Device location Floor/Site Plans with each device having a unique ID.

   c. Block Riser/Network Diagram of all devices in the system.

   d. Device Schedule of all cameras in the project.

   e. Rack Elevations for rack mounted equipment at the Head End to verify Rackspace requirements.

   f. Mounting Details for all mounted components, cameras, etc.

5. Partial or "Typical" drawings will not be accepted.

a. All drawings shall be done in CAD drafting software.

b. Duplication of Design/Bid Drawings submitted as a Shop Drawing package shall be rejected.

6. To ensure compatibility with an existing legacy network, and a project is an extension of an existing legacy system, the Security Contractor shall provide a list in electronic format/spreadsheet of all new devices with unique device ID's and mac addresses that require connection to the existing campus network. This information will be merged with existing equipment information and become an approved Table of IP addresses for the Security Contractor to use for his new equipment IP addresses.

7. Training Program documentation, including name and qualifications of trainer(s), schedule of training, curricula, and written training materials. As built drawings shall be available as part of the Training program.

8. Service information, including address of nearest representative. Provide written approval from each manufacturer affirming that Contractor is certified and approved for systems installation and service for all systems in this Section.

9. Provide Maintenance Procedures to include the following information;

   a. Provide full procedures for all tasks that must be performed to ensure the warranty remains intact.

B. Provide the following items subsequent to the Shop Drawings and Data Sheet submission in electronic format (.pdf);

1. Provide all Test Reports as indicated in Section 3.3 TESTS AND REPORTS when completed in a timely manner for approval.

2. Provide (2) complete hardcopy plus (1) electronic copy (.pdf) of Operation and Maintenance manuals for all approved equipment installed. This O&M manual shall be available for Training classes and be part of the Training materials. This document manual must be approved and available for use in Training and Final Acceptance.

3. Provide all documentation referenced in under the Warranty section referenced within this specification, and provide Warranty Certificate in electronic copy (.pdf) indicating customer name, site address, system under warranty, date warranty begins and ends, service department contact information and manufacturer contact information.

C. Submittals must be complete, as in all items listed above under Shop Drawings and Data Sheets shall be submitted at one time together as a package. Incomplete or partial Shop Drawings and Data Sheets submittals shall be rejected.

D. The Security Consultant and CCC reserve the right to reject any submittals determined to be incomplete.

E. Operation and Maintenance manual shall be submitted prior to demonstration for Final Acceptance and Training.

1.7 SUBSTITUTIONS

A. All materials and equipment shall conform to these specifications. No substitute equipment or materials may be used unless accepted in advance in writing by CCC and the Security Consultant.

B. Manufacturers listed as acceptable are normally engaged in the type of work specified. The listing of equipment part numbers or particular types of systems by specific manufacturers is to establish the performance, quality, and parameters of the equipment and material specified.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All equipment provided shall be new, not used, and shall be shipped in original packages to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturers' recommendations. Protective covering shall be provided by Contractor during construction.

B. Components to be stored for future use shall be kept inside a well ventilated space protected from weather, damage, breakage, and scoring of finishes. The Contractor shall replace, at no expense to CCC, equipment and material damaged during storage and installation as directed by CCC.

C. Products delivered to the job site in racks and consoles shall be protected from dust, dirt and foreign matter. All racks and consoles shall be protected from dents, bumps and scratching. Contractor shall replace all parts damaged in shipping or in storage with new at no cost to the Owner.

D. Used components are not permitted for installation at the Premises.

1.9 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by the Owners, civil unrest, or acts of god.

E. Provide a Certificate of Warranty to include Site name, date Warranty begin and ends, Service Provider contact information, complete street address and phone number. Contractor and manufacturer(s) shall warranty all equipment, materials and installation labor for a minimum of one (1) year from the date of written notification of Acceptance by CCC.

F. During the Warranty Period, upon notification of a problem by CCC, the Contractor shall ensure that a competent and qualified field service technician arrives on site to correct the problem within 24 hours of notification. If a problem can be corrected remotely to CCC's reasonable satisfaction, the on-site arrival time commitment shall be waived.

G. At least sixty (60) calendar days prior to expiration of Warranty, Contractor shall provide CCC with post-Warranty maintenance contract proposals. The terms and condition of any such post-Warranty program shall be consistent with those offered to the provider's most favored customer(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. System specifications, functionality, system capabilities and products outlined in this specification are based on the following;

1. VMS shall be XProtect Professional 2016 R2, by Milestone Systems, Inc., 8905 SW Nimbus Avenue, Suite 400, Beaverton, OR 97008, USA, Telephone: +1 503 350 1100, Toll-free telephone: +1 877 350 1101, Fax: +1 503 350 1199.

2. Acceptable IP camera manufacturers include Sony, Arecont Vision, Avigilon or Axis.

2.2 SYSTEM OVERVIEW

A. The security system envelope will have video surveillance cameras collocated with credential readers primarily at the perimeter entrance doors and vestibules, common areas, elevator lobbies/cabs, Administrative/Leasing office spaces, Student Lounge/Dining Rooms and other specific areas as shown on the Design Drawings. The ACS and VSS shall functionally integrate, capturing video of an off hour's perimeter breach, pedestrian/vehicle traffic or other event where cameras are placed. An example alarm event would be a "door forced open" alarm in the access control system and the associated camera records the door in alarm condition, or when a credential is swiped.

B. The video surveillance management system will be used forensically to "look" at each camera and record motion detected events only, as alarm clips. It will not have continuous recording of all cameras, and will not be monitored. The workstation to be provided shall be used to administer both the video surveillance and access control systems.

C. Computer management for the integrated security system (access control and video surveillance) shall be provided by the contractor as part of this video surveillance section, and shall consist of a 4 port desktop KVM, a slide out/lift up monitor and keyboard, USB/video cable interconnect and a 2U rack shelf.

D. Cameras for this project shall be IP type, wide dynamic range, megapixel resolution(s) and provide high definition, fluid motion, color video. The following terminology shall define the video image standards required, and provide the typical placement of cameras with associated architectural features of the property, which may require a mix of the standards listed below;

1. Identification: identification of an unknown individual or object.

a. Perimeter doors, administrative/leasing entries, stairwell entries/exits, elevator lobbies and cabs

2. Recognition: recognition of a known individual or object.

a. Perimeter doors, administrative/leasing entries, stairwell entries/exits, elevator lobbies and cabs

3. Observation: being able to interpret what is going on.

a. Common areas/hallways, student lounges, recreation rooms, waiting areas, elevator lobbies, areas of congregation, vehicle traffic/parking, outdoor/site locations.

4. Detection: detection of activity within a scene.

a. Outdoor/site locations, vehicle traffic/parking and areas of congregation.

E. The VSS shall support cameras in Elevator cabs utilizing 2 wire transmission technology with a no grip corner mount IP camera to capture activity of the elevator cab(s). Security Contractor shall coordinate wire needs for the travel cable and installation of the camera with the Elevator provider. All equipment necessary to make the elevator cameras fully operational is the responsibility of the Security Contractor.

F. The Video Surveillance system shall operate on a dedicated security system network shared with the access control system, forming the foundation of the Integrated Security System. This dedicated security network does not connect with the business network, however, this equipment is co-located in the same communications closet as the business network equipment, possibly in the same rack. Rack and wall space shall be provisioned for this equipment in the Communications Infrastructure design within the Telecommunications Closets. The specifications for this dedicated security system network shall be found in elsewhere in these specifications.

1. The Access Control Block Riser Drawing shows access control system components wall mounted in the Communications Closets indicating a connection to a local Category 6 Patch panel or reference a network port connection for this equipment. The Security Contactor shall provide all fiber optic and Category 6 patch cords to connect the access control equipment to the dedicated security network.

2. The Video Surveillance System Block Riser shall indicate the Ethernet network switches connecting to the fiber optic backbone which is part of the Structured Cabling System, an engineered and certified system provided and installed by the Communications contractor. The Security Contractor shall not provide or install any cabling or fiber for the Security System Network except the patch cords as indicated.

3. There are dedicated fiber optic strands within the existing network assigned for use by the dedicated security network, and the Security Contractor shall coordinate what fibers are identified for his equipment prior to installing this equipment. These fibers shall be identified and recorded in the As built or Record Drawings and submitted as part of the Project Close Out documentation.

4. The Security Contractor shall incorporate all requirements of the dedicated network electronics as outlined in the 28 23 00 Video Surveillance Specifications for materials, labor and required testing including all required submissions of test documentation as part of the access control system and/or the Integrated Security System.

G. Both Remote Viewing and Mobile Device viewing capabilities shall be provided as part of the NVMS/VSS system.

2.3 SYSTEM FUNCTIONS

A. Server-Based Video Recorder:

1. The system shall be a fully distributed solution, designed for multi-site and multiple server installations requiring 24/7 surveillance with support for devices from different vendors.

2. It shall be possible to connect up to 64 cameras or other devices for each recording server and for up to 5 recording servers to be connected to a single master recording server across multiple sites. The system shall support any combination of master and slave servers to provide flexibility and scalability in the overall system configuration.

3. The video management system shall support Microsoft Vista Business/ Enterprise/ Ultimate, Windows 2003 Server, Windows XP Professional, Windows 7 Professional/Enterprise/Ultimate and Windows Server 2008. All as 32-bit or 64-bit (running as 32-bit) applications and with the latest patches and service packs installed. The system shall use DirectX and .NET.

4. The following thirteen major components shall be included in the system:

   a. Surveillance system server, which shall consist of the following add-on applications/solutions or services:

   b. Recording server (a service).

   c. Management application.

   d. Image server (a service).

   e. Event server (a service).

   f. Download manager.

   g. Mobile viewing client server, a dedicated appliance shall be provided to deliver suitable video streams without consideration of a slow internet connection or lack thereof.

   h. Viewing client.

   i. Web viewing client.

   j. Standalone viewing client (for exported video recordings).

   k. Video-sharing application.

   l. Transactional data application.

   m. Graphical alarm management solution.

n. Mobile viewing client.

B. The system shall be able to incorporate a fully integrated video-sharing functionality that shall enable distributed viewing of any camera in the system, from any computer with the viewing client or video-sharing application installed.

C. The system shall include support for a graphical alarm management solution. This solution shall support continuous monitoring of the operational status and event-triggered alarms from system servers, cameras and other external devices. The solution shall visualize the status of cameras and other inputs with graphical and interactive icons.

D. The system shall include a software development kit (SDK) which shall allow for the capability of integrating the system with third-party software. The SDK shall enable the user to:

1. Retrieve live and recorded video in different ways:
   a. In raw data format, either encoded or decoded, or
   b. As a window to be resized and shown embedded in another application.
   c. Create plug-in components for the viewing client.
   d. Control the operation of video-sharing functionality.
   e. Retrieve alarm/event information.
   f. Integrate data sources for the transactional data application.
2. For further information concerning SDK, see the SOFTWARE DEVELOPMENT KIT (SDK) section.

E. The system shall provide connectivity with third-party systems and devices using the OPC (Object-Linking and Embedding Process Control) Data Access set of communication standards. The supported third-party systems must include industrial automation and SCADA (Supervisory Control and Data Acquisition) systems. The system shall support the following commands and interfaces:

1. Get configuration.
2. Get server CPU load.
3. Get camera status and frame rate.
4. Get camera and global events.
5. Set events.
6. Set the video-sharing application's live view and playback.

F. The system shall include a standalone viewing client that shall be able to show video exported from the viewing client. The standalone viewing client shall enable recipients of the video to browse and play back exported video without installing separate software on their computers.

G. The system shall be designed to support each component on the same computer for efficiency in smaller systems or in a distributed architecture for large system deployments. Video management system core components must be installed on the same server.

H. It shall be possible to install and run the system on virtualized Windows® servers.

2.4 LICENSING

A. The video management system shall require licenses for its use. There shall be two different forms of licensing connected to the system with their own separate purposes.

1. Base license code: the operator of the video management system shall be provided with a temporary license file that shall include a base license code for the video management system that shall allow for a trial period of 30 days. The temporary license file shall be used in the installation process and must be replaced by a permanent license file before the completion of the 30-day trial period.

2. Device license key: every hardware device added to the video management system shall require a separate device license key that is unique to the hardware device in question.

3. A 30-day grace period shall be activated once cameras have been added to the video management system.

4. It shall be possible to activate all hardware devices in the system using one, single license file.

a. If activation of the license file takes place after the 30-day grace period, cameras that are not activated shall become unavailable in the video management system. Activation of the license file shall restore activation of the cameras.

b. The base license code must be registered before device license keys can be activated.

B. Registration of the video management system shall be possible as online activation and offline activation of licenses via the management application.

1. Online activation shall be available via the management application for computers that have access to the internet. It shall be possible to specify the number of licenses wanted for each device.

2. Offline activation shall be available via the management application for computers that do not have access to the internet. It shall be possible export a license file to an external device, and then activate the license file on a different computer with internet access, by logging on to the website of the video management system provider from the computer with internet access.

3. The operator must enter a valid email address to which the license file can be sent.

4. It shall be possible to import the received license file in the management application after which the permanent license file shall be activated in the video management software.

2.5 VIDEO DEVICE DRIVERS AND SUPPORTED DEVICES

A. The system shall support installation of video device drivers (program components used for communication with the camera/devices connected to a recording server).

B. Video device drivers for supported devices shall be automatically loaded during the initial installation of the system.

C. It shall be possible to download newly released device drivers from the website of the video management system provider if the administrator is connecting a device to which the driver is not already loaded.

D. The supported camera and encoder model numbers shall be listed for each manufacturer on an up-to-date web site.

E. The video management system shall support future camera and encoders models as support becomes available without having to reconfigure the system.

F. Camera device drivers shall be decoupled from the video management software which shall not require to be updated or re-configured in order to work with the new camera device drivers.

G. The video management system shall support devices from most manufacturers.

H. The system shall support interoperability with IP camera standards including, at a minimum, the Physical Security Interoperability Alliance (PSIA) and the Open Network Video Interface Forum (ONVIF).

I. The recording servers shall support cameras with universal serial bus (USB) communications.

J. The system shall include a universal driver that shall support any generic network camera responding to the ARP (Address Resolution Protocol). The driver must be able to handle standard video streaming formats including MJPEG, MPEG4 and H.264.

K. The system shall support specific hardware devices, and the specific supported model numbers shall be listed for each manufacturer on an up-to-date online website.

L. The video management system shall support the use of 360° panomorph video technology.
   1. It shall be possible to enable the use of 360° lens technology in the management application.
   2. It shall be possible to enable panomorph support in the management application.
   3. It shall be possible to change lens type and add additional panomorph lens types to the management application.
   4. It shall be possible to define the physical location of the hardware device, for example on a wall, on the ground or in the ceiling.

M. Hardware devices supporting 360° lens technology shall require a special license key. It shall be possible to activate the license key on the video management system provider's website.

N. The surveillance system server shall support the PTZ protocols of the supported devices. The surveillance system server shall support both absolute positioning PTZ protocols that shall be able to move the camera to a specific X, Y, and Z set of coordinate positions, and relative positioning PTZ protocols that shall be able to move the camera to a relative extent, based on the camera's current position.

O. The surveillance system server shall support full two-way audio between viewing clients/web viewing clients and remote cameras/devices. Two-way audio integration shall support the following features and functions:

1. Outgoing audio – microphone inputs to viewing clients shall transmit audio streams to speakers attached to remote IP devices. Selectable options shall be one-to-one (send audio to a specific IP device), and one-to-all (broadcast to all IP devices).

2. Audio from IP devices with microphones shall be transmitted to, and recorded by, the recording server. The audio shall be transmitted to computers with a viewing client and installed speakers.

3. Each speaker and microphone shall be assigned to a specific camera/device. The speaker and microphone shall have the capability to be assigned to other devices as well.

P. For export purposes, the system shall support 56-bit encryption of video. The 56-bit encryption shall meet the US Government requirements on export limits for encryption.

Q. The system shall support the use of computers, servers, storage hardware and switches from any manufacturer.

R. The video management system shall be able to run on the following operating system setup:

1. Microsoft Vista Business/Enterprise/ Ultimate, Windows 2003 Server, Windows XP Professional, Windows 7 Professional/Enterprise/Ultimate and Windows Server 2008. All 32-bit or 64-bit (running as a 32-bit application).

2.6 SYSTEM LOGGING

A. The system shall be able to log all system activity:

B. The system shall generate log files in editable text format. Log files shall track the overall system operation and usage. The log files shall be stored directly in a local file, or any other user-defined file directory specified by a system administrator. Administrators shall be able to define how long (in days) the log files shall be retained by the system.

C. The system shall generate the following log files:

1. Management application log files shall log activity in the management application. It shall not be possible to disable this type of logging. The file name shall provide a descriptive name prefix followed by a date code. The file type extension shall be '.log'.

2. Recording server service log files shall log the recording server service activity. It must not be possible to disable this type of logging. The file name shall provide a descriptive name prefix followed by a date code. The file type extension shall be '.log'.

3. Image server service log files shall log activity on the image server service. It must not be possible to disable this type of logging. The file name shall provide a descriptive name prefix followed by a date code. The file type extension shall be '.log'.

4. Image import service log files shall log activity regarding the image import service, when this service is used for fetching pre-alarm images, and storing the fetched images in camera databases. A pre-alarm image feature shall be available and shall enable the sending of images from the camera to the surveillance system, from immediately before an event took place, by the means of an e-mail. It must not be possible to disable this type of logging. The file name shall provide a descriptive name prefix followed by a date code. The file type extension shall be '.log'.

5. Event log files shall log information about registered events. It must not be possible to disable this type of logging. Event log files shall be viewable in both viewing clients and standalone viewing clients.

6. Audit log files shall log user activity in web viewing clients and viewing clients, provided that audit logging is enabled. Audit log files shall be named according to the structure is_auditYYYYMMDD.log.

7. Standalone viewing client export log files shall log activity regarding database export from the standalone viewing client. Exported databases as well as export log files shall by default be placed in an exported images folder on the desktop of the computer, on which the export was performed. The file name shall provide a descriptive name prefix followed by a date code. The file type extension shall be '.log'. As with the exported database files themselves, the standalone viewing client export log files must be encrypted and/or compressed, whereas the file extension shall be modified to ".mzi" or ".men".

8. Each log file shall be generated daily, unless the system components or features are not used.

9. The system shall provide an integrity check function where all log files, except the management application log files, must be checked once every 24 hours. The result of the integrity check shall automatically be written to a file named according to the structure LogCheck YYYYMMDD.log.

2.7 SURVEILLANCE SYSTEM SERVER(S)

A. The surveillance system server shall consist of the following add-on applications or services:
   1. Recording server (a service).
   2. Management application.
   3. Image server (a service).
   4. Download manager.
   5. Mobile viewing client server - a dedicated appliance shall be provided to deliver suitable video streams without consideration of a slow internet connection or lack thereof.

B. The surveillance system server shall support a master/slave setup of the image servers (a service running on the surveillance system server) and, in this way, enable the operator to connect to all image servers in the system by connecting to only the master image server.

C. The surveillance system server shall support the use of separate networks, VLANs or switches for connecting the cameras to the recording servers. The system shall provide physical network separation from the clients and facilitate the use of static IP addresses for the devices.

D. The surveillance system server shall support H.264, MPEG-4 (both ASP and SP), and MJPEG compression formats for the video stream from all devices including analog cameras connected to encoders, DVRs, and IP cameras connected to the system. In addition, the system shall support the MxPEG video compression algorithm, which is unique to Mobotix. MxPEG encoding shall have the capability to maintain high image quality for megapixel cameras while dramatically decreasing bandwidth consumption.

E. The surveillance system server shall be able to record the native camera frame rate and resolution (NTSC, PAL, HD or Megapixel), or as configured in the management application.

F. The system shall support port forwarding, and shall enable clients from outside of a Network Address Translation (NAT) firewall to connect to recording servers without using a VPN.

G. Each server shall be mapped to a specific port and this port shall be forwarded through the firewall to the recording server's internal IP address.

2.8 RECORDING SERVER

H. Recording servers shall be able to record video feeds and communicate with cameras and other devices.

I. The system shall support an unlimited number of recording servers. One or more recording servers shall be used in a system, depending on the number of cameras or the configuration of the physical system.

J. The recording server shall support the use of pre- and post-recording on motion/event recording. Number of seconds for pre- and post-recording time periods shall be independently configurable.

K. Each recording server shall have a default storage area – one or several folders - where the database content, primarily recordings from the connected cameras, shall be stored. Recordings from each connected cameras shall be stored in individual camera databases. The system shall allocate an unlimited amount of storage for each connected device.

L. An administrator shall be able to enable archiving on a per camera basis and define the archiving drive for each camera.

M. The recording server shall be able to use high performance iSCSI, SCSI, SAS, or SSD disk drives for recent recordings and use lower cost SATA drives for the RAID arrays for archived recordings. Use of online archiving shall ensure that data always is readily available. Viewing video from either the recent storage or the archive storage shall be transparent to the operator.

N. The archiving shall happen transparently and shall enable operators of viewing client to access archive recordings without the need to restore the archived video to a local hard drive.

O. System administrators shall be able to define storage areas for the specific camera databases and define new storage areas on the recording server, or on a connected network drive. The system shall support repair or archive of recordings in the event a connected network drive will become unavailable, so that no recordings will be lost.

P. The surveillance system server shall save local databases a defined number of days or hours. The database retention settings must regulate how long recordings shall remain in a camera's database before the recordings are archived.

Q. The surveillance system server shall support archiving (an automatic transfer) of recordings from a camera's default database to another location on a time-schedule, without the need for user action, or initiation of the archiving process. Archiving shall support that the duration of the camera's recordings can exceed the camera's default database capacity. Archives shall be located on either the recording server computer or on a connected network drive. If the storage area on a network drive becomes unavailable for recording, the system shall be able to trigger actions such as automatic e-mails to defined personnel.

R. The system shall support efficient creation and management of the recording server's archives.

S. The recording server(s) shall have the ability to support multiple Network Interface Cards (NICs) and be able to support connection to the cameras, DVRs and encoder devices on a network separate from the viewing client.

T. The recording server shall run as a service and must typically be installed on dedicated computer(s).

U. The recording server operational status shall be displayed via an icon in the system tray. Right-clicking the recording server icon shall open the following status and control functionality:

1. Status icon - recording server is running.
2. Status icon - recording server is stopped.
3. Control - stop recording.
4. Control - start recording.
5. Control - view system status.
6. Control - view recording and image server log files.

V. The recording server shall continuously log server status messages that shall be possible to view by clicking a status icon in the system tray.

W. Bandwidth management

1. The recording server shall offer the following options for managing bandwidth utilization (camera device dependent):
   a. CODEC selection; MJPEG, MPEG-4, MxPEG, or H.264.
   b. Resolution.
   c. Frame rate.

d. Compression.

e. Bandwidth setting.

f. Fixed or variable bit rate setting.

2. From the viewing client, operators shall have the possibility to have video images continually streamed or only updated on motion to conserve bandwidth between the viewing client and the recording server.

2.9 MANAGEMENT APPLICATION

A. The management application shall provide a feature rich and intuitive interface for initial configuration and day to day administration of the system.

B. The management application shall incorporate adaptable application behavior features whereby novice users shall be guided while expert operators shall be able to optimize the application for efficient use.

C. The management application's graphical user interface shall as minimum support the following languages: American English, Simplified Chinese, Traditional Chinese, Danish, German, French, Italian, Japanese, Portuguese (Brazilian), Russian and Spanish.

D. The management application shall provide configuration of the system through both pre-defined wizards as well as directly through a tree-style advanced configuration method. Wizards shall support configuration of the following:

1. Add hardware devices:

a. The management application shall contain an add hardware devices wizard that shall enable easy handling of devices:

b. The management application shall support addition of cameras, video encoders, digital video recorders, microphones, speakers, and other hardware devices to the system, through an automated wizard.

c. The add hardware devices wizard shall automatically detect new devices to be enrolled in the system. Upon detection, the wizard shall display the device IP address, network port, and hardware device driver. The wizard shall use the following technologies to automatically detect devices:

d. Universal Plug and Play (uPnP).

e. Broadcast.

f. IP-ranging scanning

2. The add hardware devices wizard shall offer four ways of adding hardware devices:

a. Express:

b. The express method shall quickly scan the network for devices supporting device auto-discovery, auto-recognize these devices and automatically add appropriate information into the management application.

c. The express method shall detect all devices supporting auto-discovery attached to the same layer 2 network, as the system server.

d. The express method shall make it possible for system administrators to enable or disable each discovered device.

e. The express method shall enable systems administrators to change the names of each of the discovered devices, or to apply one of a minimum of seven (7) pre-defined naming conventions to the discovered devices.

f. Advanced

g. The advanced method shall scan the network for hardware devices based on criteria provided by the system administrator regarding required IP ranges, discovery methods, drivers, and device user names and passwords.

3. The advanced method shall enable system administrators to select the following criteria upon which to scan:

   a. IP address range (may not be same network segment as server).

   b. TCP port scanning.

   c. Port numbers.

   d. Device drivers to use.

   e. Device user name and password.

   f. Manual

4. The manual method shall enable system administrators to manually specify all of the information necessary for each hardware device separately, to provide for simple addition of a few hardware devices.

5. The manual method shall provide configuration of the following device variables:

   a. Command system to use or to ignore devices discovered by scan.

   b. Device address.

   c. Device user name and password.

   d. Device hardware driver.

   e. Import from CSV file: the add devices wizard shall enable system administrators to import device data via a comma-separated values file directly to the system.

6. Configure video and recording wizard:

   a. The management application shall contain a wizard for configuring video and recording, for quick and convenient configuration of cameras' video and recording properties.

   b. The wizard shall enable camera-specific configuration of video settings such as the following:

      i. Bandwidth utilization.

      ii. Image brightness.

iii. Compression technology.

iv. Video contrast.

v. Image resolution.

vi. Image rotation.

7. Online schedule.

   a. The configure video and recording wizard shall provide configuration of schedules to control when each camera transfers video to the system server for live viewing and further processing. When a camera is transferring video, the system server for processing shall be online, otherwise it shall be offline.

   b. The system administrator shall be able to initially select between two default online schedules.

   c. Always on: shall enable the camera to always be online.

   d. Always off: shall cause the camera to never be online.

8. The wizard shall enable system administrators to create custom online schedules according to the needs of the operators, and shall enable any of those schedules to be applied to any of the cameras from within the wizard. The custom schedules shall support the following functionality:

   a. Online in specific periods of time.

   b. Online on the occurrence of specific events.

   c. The wizard shall provide a feature whereby the same schedule must be applied to all cameras within the system with a maximum of two mouse clicks.

9. The configure video and recording wizard shall provide the following live and recording settings for all cameras within the system:

   a. Live frame rate (in frames per second).

   b. Recording frame rate (in frames per second).

   c. Record:

      i. On motion detection: the camera shall record whenever motion is detected.

      ii. Always: video from the camera shall be recorded at all times. This feature shall support time-based recording according to the camera's online schedule.

      iii. Never: only live video from the camera shall be displayed but video shall not be recorded.

      iv. Event: the camera shall record upon pre-defined events configured in the camera setup.

      v. Motion detection & event: the camera shall record on the basis of motion and pre-defined events configured in the camera setup.

   d. Pre-recording time.

e. Post-recording time.

f. The configure video and recording wizard shall support that only keyframes are recorded on MPEG cameras connected to the system. Keyframes shall be defined as those frames in which the entire view of the camera shall be captured.

g. The wizard shall provide a template whereby changes must be made to all cameras in the system at the same time with a maximum of two mouse clicks.

10. Dual streaming

a. It shall be possible to enable dual streaming for cameras that support this functionality.

b. A dedicated live stream shall be available for enabling. This shall allow operators to use an alternate camera stream and enable two independent streams to the recording server. One stream shall be used for live streaming and the other shall be used for playback purposes. It shall be possible to define different resolutions, encodings and frame rates for each individual stream.

11. Privacy mask

a. The management application shall allow an administrator to define privacy masks, where areas of a camera image can be blocked from a view in the viewing client and/or web viewing client as well as in any exported video material.

i. The privacy mask shall be indicated through a black blurring hiding the selected area(s) in the view in live, playback and setup mode in the viewing client and the web viewing client.

ii. It shall not be possible to switch off the privacy masking from the viewing client and/or the web viewing client.

b. In certain cases where original images are needed, without any privacy mask attached, it shall be possible for the administrator to switch off the privacy mask. This shall only be done from the management application, and only by personnel with rights to perform this action. When the privacy mask is disabled, the hidden areas of the image shall then be visible in the viewing client and/or the web viewing client.

c. The management application shall allow the setting of a different privacy mask for each activated stream from the camera.

d. The privacy masking function shall be capable of covering the same percentage of an image when changing resolution. If, for example, the privacy masking covers a 640×480 pixels image and the resolution is later changed to, for example, 1024×768, the privacy masking shall cover the same area of the image with the new resolution.

12. Drive selection

a. The wizard shall enable system administrators to specify on which system drives recordings from cameras shall be stored. The system shall support separate drives or paths for recorded and archived video.

b. The system shall support both local and network drives/paths.

c. The wizard shall enable system administrators to select the purpose of each of the drives configured within the system. These purposes shall be as follows:

i. Not in use: the selected drive shall not be used.

ii. Recording: the drive shall be used for recording of video directly from cameras to the system database. This option shall only be available for local drives on the system server.

iii. Archiving: the drive shall be used for transfer of recorded video to archive. This drive shall either be on the system server or on a network.

iv. Recording and archiving: the drive shall be used for storage of both video recorded to the system server database as well as for archived video. This option shall only be available for local drives on the system server.

d. The wizard shall enable system administrators to specify the path on the drive in which recorded or archived video shall be stored.

e. The configure video and recording wizard shall display the total size of the selected drive and the amount of free space on the drive.

f. The system shall provide dynamic path selection for archived video. This feature shall enable system administrators to configure multiple recording drives, and the system software to automatically select the most appropriate recording location based in part on the amount of free space available. This functionality must be transparent to the user of the system. The operation shall appear to users as if all archived video is stored in a single location.

g. The wizard shall enable system administrators to specify a network drive path in UNC format for archive video.

h. The configure video and recording wizard shall enable system administrators to specify when the system shall move recordings from the recorded video database to the archive locations. The system shall support up to twenty-four (24) archiving times per day, with a minimum of one hour between each one.

13. Recording and archiving settings

a. The configure video and recording wizard shall enable system administrators to select the recording and archiving paths for each individual camera.

b. The configure video and recording wizard shall enable system administrators to specify the total amount of time for which recordings from each camera shall be retained in the recorded database and the archive as a total.

c. The configure video and recording wizard shall provide a template whereby changes shall be made to all cameras in the system at the same time with a maximum of two mouse clicks.

14. Adjust motion detection wizard

a. The adjust motion detection wizard shall enable system administrators to quickly configure motion detection and excluded regions properties for all cameras within the system.

i. Exclude regions

ii. The system shall provide a utility whereby motion detection in specific regions, within the view of each camera, shall be disabled to avoid detection of irrelevant motion, for example trees swaying in the wind, or cars regularly passing by in the background.

iii. The system shall provide a grid pattern over the view of each camera. Exclude regions shall be configured by the system administrator by selecting the appropriate grid boxes to exclude from motion detection. Left clicking on grid boxes shall select

exclude motion detection, and right-clicking on grid boxes shall clear exclude motion detection.

15. Motion detection
    a. The wizard shall support for configuration of motion detection settings individually for each camera, or for multiple cameras at once.
    b. It shall be possible decide whether motion detection shall take place on all video or if it shall only apply to keyframes.
    c. It shall be possible to carry out motion detection on downscaled video in different percentage of scaling.
    d. The wizard shall provide a sensitivity utility in the form of a slider control. The slider control shall be able to adjust the sensitivity of the motion detection so that irrelevant background noise can be filtered out. The video management system software must indicate inside a video preview whether or not motion shall be detected and shall change as the sensitivity is adjusted. As an alternative to the slider control, it shall be possible to enter a number between 0 and 256 to adjust the sensitivity of the motion detection.
    e. The wizard shall incorporate a motion adjustment utility in the form of a slider control. The slider control shall be able to adjust the threshold level concerning the amount of motion necessary to indicate to the system that motion has occurred in the scene of the camera. The system shall provide a motion level bar above the slider control to indicate the threshold level, at which the motion slider is set. The motion level bar shall change color from green to red when motion is detected. As an alternative to using the slider, the system software shall enable system administrators to enter a value between 0 and 10,000 in an associated field.
    f. In order to conserve server processing resources, the system shall support adjustment of the interval at which the system software shall evaluate motion detection. The interval shall be applied regardless of the camera frame rate.
    g. It shall be possible to disable motion detection if no motion detection is required.

16. Configure user access wizard
    a. The configure user access wizard shall provide quick configuration of viewing client software access to the system server, as well as which operators are able to access the viewing clients.
    b. The wizard shall provide the following server access settings:
        i. Name of the system server, as it shall appear in clients.
        ii. Port number that shall be used for communications between viewing clients and the system server.
        iii. Language/character set that shall be used on the system server.
        iv. Allow or deny access to the server from the internet through a firewall or router.
        v. Public IP address or host name that shall be used when the server is available from the internet.
        vi. Port number that shall be used for connection to the server from the internet.

c. The wizard shall enable system administrators to add users as basic system users, as Windows users, or as a combination of both:

i. Basic user: the wizard shall incorporate the ability to create user access accounts with basic user name and password authentication for each individual user, managed and authenticated solely through the system server.

ii. Windows user: system software shall support users imported from a list defined locally on the server.

d. After completing configuration using the wizard, the system shall indicate which cameras the operators shall have access to.

2.10 ADVANCED CONFIGURATION OF THE MANAGEMENT APPLICATION

A. The following items shall be selectable for advanced configuration:

1. Hardware devices
2. Cameras and storage information
3. Events and output
4. Scheduling and archiving
5. Video-sharing functionality
6. Logs
7. E-mail
8. SMS
9. Graphical alarm management
10. Server access
11. Master/slave
12. Users
13. Services
14. Alarms Management

B. Advanced configuration for all components within the system shall be accessible through an easily navigable tree structure. Upon expanding any item within the tree, information related to that item or category of items shall be displayed in the management application window.

C. The tree shall provide simple navigation features such as menus of actions that must be taken by right-clicking on headings within the tree and by double-clicking on items within the tree.

D. Hardware devices

1. All information related to hardware devices connected to the system shall be displayed within the hardware devices heading within the system tree. Upon expanding the hardware devices heading, all hardware devices connected to the system shall be displayed. Clicking on any of the hardware devices shall display information relative to that specific device for viewing or editing.

2. The advanced configuration shall support editing of device-specific properties outside of the wizards. The following properties shall as a minimum be editable:
   a. IP address
   b. Video channel enabling/disabling.
   c. Hardware device name.
   d. HTTP or FTP port.
   e. Device user name/password.
   f. Hardware type.
   g. Serial number (MAC address).
   h. Camera pan/tilt/zoom enabling.
   i. COM ports or port address for control of camera pan, tilt and zoom function.
   j. Enabling of 360° degree lens camera.

3. The advanced configuration tree shall incorporate a replace hardware device wizard to simplify the procedure for replacing any existing hardware device.
   a. The wizard shall automate editing of the following fields:
   b. Hardware device address.
   c. Hardware device port.
   d. User name/password.
   e. Device driver.

4. Camera and database action:
   a. The replace hardware device wizard shall automate the process of updating the database and inheriting camera properties for each channel on the device.
   b. System administrators shall have the option of the device inheriting the existing database for the device, deleting the existing database or leaving the existing database.

5. The advanced configuration tree shall support configuration of dedicated input/output (I/O) devices within the system. Inputs on these devices shall be able to initiate events within the system, and system events shall be able to activate outputs for control of external systems or components.

E. Cameras and storage information

1. Video, recording and shared settings for all cameras shall be editable within the advanced configuration tree. The advanced configuration tree shall provide both general and camera-specific methods to configure cameras and storage properties.

2. General

   a. General recording and storage properties shall enable system administrators to edit certain properties for many cameras at one time using templates. In addition to those elements specified within the configure video and recording wizard, the system shall support configuration of the following properties:

   b. Configuration of keyboard shortcuts, which shall enable operators to toggle between viewing video from different cameras.

   c. Configuration of event-based recording, where the system administrator shall have the capability to specify both start and stop events.

   d. Enable manual recording that shall include configuration of default duration and maximum duration of manual recording initiated by authorized operators.

   e. Audio selection associated with specific cameras, shall include selection of default microphone and default speaker.

   f. Enable or disable audio recording for all cameras.

   g. Storage information for the system and all drives/paths shall be displayed within the general recording and storage properties feature.

3. Camera-specific

   a. In addition to those properties described within the configure video and recording wizard, the adjust motion detection wizard, and the general properties above, the following shall be configurable within the camera-specific properties:

   b. Speedup control so that a camera's live and/or recording frame rate speeds up on motion or upon the activation of specified system events.

   c. Configuration of device-specific properties supported by the device's manufacturer.

   d. Configuration of events associated with the camera and device in question so that events can be associated with notifications in the viewing clients.

   e. Configuration of outputs associated with the specific camera in question.

   f. Setup of pan, tilt and zoom preset positions. The system shall support setup of preset positions on the server, imported from the camera, or stored on the camera.

   g. Configuration of pan, tilt and zoom patrolling. Patrolling features that shall be configured includes the following:

      i. Patrolling profiles that determine the sequence of the patrol.

      ii. Preset positions to use in a patrolling profile.

      iii. Wait and transition times for a patrolling profile.

      iv. Pan, tilt and zoom scanning (continuous panning.)

      v. Pausing pan, tilt and zoom patrolling.

vi. Configuration of pan, tilt and zoom presets on event.

F. Events and output

1. The advanced configuration tree shall support configuration of events so that they can automatically trigger actions in the system, including activation of outputs.

2. The system shall provide for configuration of the following:

a. Ports and polling properties shall include:

i. Alert and generic event port.

ii. SMTP event port.

iii. FTP event port.

iv. Polling interval.

b. Hardware input events.

c. Manual events, triggered by authorized users.

d. Generic events shall support integration with third party systems such as access control and alarm monitoring systems. These events shall have the following configurable properties:

i. Event name.

ii. Event port.

iii. Content elements, defining the specific text that activates the event.

iv. Assembly of content elements, defining the collection of content elements initiating an event.

v. Event priority.

vi. Event protocol, which shall support selection of which type of event protocol, TCP or UDP is monitored.

vii. Event rule type, which shall make it possible to specify whether the event message expression is an exact match or match only part of a larger message.

viii. Send e-mail if event occurs.

ix. Attach image from camera.

x. Send SMS if event occurs.

e. Timer events, which shall occur a specified number of seconds or minutes after the event under which they are defined has occurred.

f. Hardware output configuration, including the following properties:

i. Output name.

ii. Port to which output is connected.

iii. Amount of time for which output should be applied.

g. Configuration of hardware output on events so that outputs are activated upon initiation of specific events.

G. Scheduling and archiving

1. The advanced configuration tree shall provide configuration of general and camera-specific properties.
2. General configuration:
   a. Advanced configuration of scheduling and archiving shall enable system administrators to configure schedules to control the following camera properties:
      i. Online/offline.
      ii. Speedup.
      iii. E-mail notification.
      iv. SMS notification.
      v. PTZ patrolling.
3. The following scheduling options must be available for configuration:
      i. Start cameras on client requests: shall enable operators of viewing clients to force a camera to be online even if it is outside the camera's normal online schedule without triggering recording.
      ii. A start manual recording feature shall be available for operators given the rights to turn on recording.
      iii. Default schedule profile for new cameras.
      iv. Maximum delay between reconnect attempts.
4. The following archiving properties shall be configurable:
      i. Archiving time.
      ii. Send e-mail on archive failure.
      iii. Send SMS on archive failure.
5. Camera-specific configuration:
   a. The system shall provide a calendar function in which periods of minimum 5 minutes can be defined.
   b. Clicking and dragging on any day within the week, shall select the time period and enable it for the appropriate schedule.
   c. Schedules for the following must be available:
      i. Online period.
      ii. Speedup.
      iii. E-mail notification.
      iv. SMS notification.

v. PTZ patrolling.

H. The system shall support configuration and use of video-sharing functionality. The video-sharing functionality shall be available for configuration in the management application which shall include a configuration tab and event tab:

1. Configuration tab shall provide status and shall support configuration of individual computer displays to be used as video-sharing recipients. The tab shall provide the following options:

   a. A status window that shall list all video-sharing recipients in the system. The status window shall show the following properties for each video-sharing recipient in the system:

      i. User-defined name.

      ii. IP address.

      iii. IP port number.

      iv. Password.

      v. Enable/disable status for shared video to be displayed in viewing clients defined as video-sharing recipients.

      vi. A user interface to add, clear, and update video-sharing functionality settings.

2. An event tab shall support configuration of live video to be presented by video-sharing recipients upon selected predefined events.

   a. The event tab shall make it easy to select events that trigger sharing of live video viewing on the video-sharing recipients.

   b. The event tab configuration menu shall provide an easy to use interface to select which video feed/device that shall be displayed on the video-sharing recipient when a specific event happens.

I. Logs

1. The system shall generate the following log files:

   a. Management application.

   b. Recording server service.

   c. Image server service.

   d. Image import service.

   e. Event.

   f. Audit

   g. Standalone viewing client export.

2. An advanced configuration tree shall enable system administrators to specify where the log files are saved.

3. The system shall provide possibility for log integrity check, minimum once each 24 hours.

J. The system shall support e-mail messaging with the following options:

1. Possibility to enable/disable e-mail while the recording server is running.
2. Possibility to enable/disable e-mail from within the viewing client. This feature shall allow or restrict operators' access to send evidence files as an e-mail attachment.
3. Setup e-mail account information:
    a. Recipients.
    b. Sender e-mail address.
    c. Outgoing SMTP (Simple Mail Transport Protocol) server name.
    d. Enable/disable e-mail server login.
    e. Username.
    f. Password.
    g. Subject text.
    h. Message text.
    i. Enable/disable the attachment of an image in the e-mail.
    j. Minimum time between e-mail transmissions.
    k. Send a test e-mail using the current settings.

K. The system shall support SMS messaging with the following options:
1. Possibility to enable/disable SMS messaging.
2. Set the GSM modem communication port.
3. Set the SIM card PIN code.
4. Set the SIM card PUK code.
5. Set the SMS central phone number.
6. Set the recipient phone number.
7. Set a default message.
8. Set the minimum time between SMS message transmissions.
9. Send a test SMS message using the current settings.

L. Graphical alarm management
1. For further information concerning graphical alarm management, see the GRAPHICAL ALARM MANAGEMENT SOLUTION section.

M. Server access
1. An advanced configuration tree shall provide configuration of the following properties:
    a. Server name.
    b. Local port.
    c. Enable/disable internet access.

d. Maximum number of clients.

2. The system shall enable system administrators to specify IP address ranges that the system shall be able to recognize as coming from the local network.

3. The system server shall be able to support multiple language/character sets.

N. Master/slave

1. The system shall support any server to function as a master server. Each master server shall be able to be assigned a series of slave servers in the management application. When selecting a master server from the viewing clients, it shall be possible to view and manage all cameras/devices connected to each master, plus all cameras/devices assigned to each slave. The settings for the master/slave image server setup shall be:

   a. Select a specific server as a master server.

2. The user interface shall enable system administrators to add slave servers. Each slave server shall be added to a list of assigned slaves for each master.

3. The user interface shall enable system administrators to delete a specific slave server from a list of slaves available to a master.

4. It shall be possible to update the connection status between master and slave servers.

   a. A status dialog shall inform operators of the status of the selected slave server.

   b. It shall be possible to check the connection status of multiple slave servers at the same time.

O. Users

1. The advanced configuration tree shall support configuration of the following properties in addition to those specified in the configure user access wizard:

   a. General access settings where system administrators shall have the ability to grant or restrict access to the following system functions:

      i. Live view.

      ii. Playback.

      iii. Setup.

      iv. Create/edit shared views.

      v. Create/edit private views.

   b. Camera access settings

      a. System administrators shall be able to grant or deny access to each camera in the system.

      b. The system administrator shall be able to grant or restrict the following access rights parameters:

      i. PTZ control.

ii. PTZ preset positions.

iii. Output.

iv. Events.

v. Incoming audio.

vi. Outgoing audio.

vii. Manual recording.

viii. AVI/MJPEG export.

ix. Database export.

x. Sequences.

xi. Fast search feature.

xii. Recorded audio.

2. The system shall support configuration of user groups to simplify management of multiple user accounts with similar properties.

P. An advanced configuration tree shall provide the ability to monitor, start, stop and restart system services.

Q. Alarms

1. For more information about alarms, see the ALARM section.

2.11 ALARMS

A. The alarms feature shall use functionality handled by the event server. It shall provide central overview, control and scalability of alarms in any number of installations of the video management system software in an organization.

B. It shall be possible to define the following general settings for alarms:

1. The number of days for which to keep closed alarms (alarms closed, ignored or rejected). There shall be a default value that shall indicate the number of days to keep the alarms, which by default shall be 1. It shall be possible to define from 1 to 99,999 days. The value 0 shall indicate that alarms are to be kept indefinitely.

2. The number of days to keep all other alarms (alarms not closed, ignored or rejected). There shall be a default value that shall indicate the number of days to keep the alarms, which by default shall be 30 days. It shall be possible to define from 1 to 99,999 days. The value 0 shall indicate that alarms are to be kept indefinitely.

3. The number of days to keep alarm logs for. There shall be a default value that shall indicate the days to keep the alarms, which by default shall be 30 days. It shall be possible to define from 1 to 99,999 days. The value 0 shall indicate that alarms are to be kept indefinitely.

4. To save a separate log of server communication in addition to the regular log.

C. The alarms feature shall include an alarms configuration that shall allow for:

1. Enabling of the individual alarms.

2. Naming the alarm. The name shall appear whenever the alarm is listed.
3. Typing in an optional description text, for example a description of the procedure to undertake in the event of an alarm being triggered.
4. Specifying a triggering event. This shall let operators select the event which should be in use when the alarm is triggered. The list shall include both system-related events and plug-ins.
5. Selecting the camera or other device, including plug-in defined sources, from which the event should originate in order to trigger the alarm.
6. Choosing which type of triggering function should be active. An alarm activation option shall allow the operator to choose between two different ways of alarm activation:
    a. Time profile-based: the operator shall be able to define periods of time when the alarm should be enabled for triggering.
    b. Event-based: the operator shall be able to select which events should start and stop the alarm. It shall be possible to select the following type of events:
        i. Hardware-events defined on cameras.
        ii. Video servers and in- and output.
        iii. Global/manual event definitions.
    c. Selecting cameras to be included in the alarm definition even if they are not themselves triggering the alarm, for example if you have selected an external event message (for example a door being opened) as the source of the alarm.
    d. Selecting a priority for the alarm. It shall be possible to choose between high, medium or low.
    e. Defining an event to be triggered by the alarm in the viewing client.
    f. Selecting if the alarm should be closed automatically upon a particular event.

2.12 SOFTWARE DEVELOPMENT KIT (SDK)

A. The video management system shall support a software development kit (SDK) that shall allow for integrating the video management system with third-party applications, for example access control, video analytics, etc.

B. Integration of third-party developed applications and plug-ins shall be possible in three different ways:

1. Integration through protocol shall allow for the possibility to choose coding platform.
    a. Protocol integration shall make it possible to:
        i. Access the video management system's configuration.
        ii. Retrieve live or recorded video and audio.
        iii. Send control commands and events to the video management system.
        iv. Receive video management system status information, for example if a camera is down or a server is running out of space.

v. Implement protocols on Windows, Java® and Linux® systems.

vi. Integration through the .NET-framework which shall allow for using software components to integrate with the video management system.

b. .NET-framework integration shall make it possible to:

i. Access the video management system's configuration.

ii. Display live and recorded video with optional overlay of graphics.

iii. Play live and recorded audio.

iv. Issue control commands.

v. Send and receive events to the video management system.

2. Integration through a plug-in embedded directly into the video management system environment that shall run as part of the video management system and client applications.

a. Plug-in integration shall make it possible to:

i. Be integrated with the event server, enabling the event server to use plug-in functionality.

ii. Be integrated with the viewing client, enabling the viewing client to use plug-in functionality.

iii. Be integrated with the management application, enabling the management application to use plug-in functionality

b. Plug-ins shall be able to run across all products and versions of the video management software.

c. Plug-ins shall be able to listen for events from other plug-ins.

d. It shall be possible activate licenses for third party plug-ins in the management application.

C. Third-party developed applications shall be able to integrate with the video management system to access a variety of program functionalities:

1. Video and audio functionality.

a. Retrieve and display live and recorded video.

b. Retrieve and play live and recorded audio.

c. Retrieve and display single frame JPEG images.

d. Video and audio export in AVI and database format.

e. Place overlay information on live and recorded video in component-based implementation and in plug-ins for the viewing client.

2. Event and alarms

a. Trigger internal (system-related) and external (integrated) events and alarms.

b. Retrieve a list of triggered alarms.

3. Security
   a. Manage user rights on plug-in functionality.
   b. A framework for system access and security token handling.
4. Configuration
   a. Retrieve video management system configuration, including camera, user and alarm information.
   b. Enable third party applications to save and retrieve their own configuration.
5. Control
   a. Send PTZ commands to cameras.
   b. Retrieve PTZ position from absolute PTZ cameras.
   c. Send a start or stop recording event from a specific event.
   d. Activate external output.
   e. Control video wall application functionality.
   f. Send camera to a matrix monitor.
   g. Send commands to third-party-developed plug-ins.
6. System status
   a. Receive all status messages from the video management system, including server disk, CPU usage, and triggered events.

D. Applications developed with the SDK shall integrate with both the management application and the viewing client.
   1. It shall be possible to develop plug-ins for the viewing client, the management application and the event server.
   2. It shall be possible to run custom-made applications and configuration in the management application.
   3. An event server plug-in shall make it possible to develop functionalities that shall run as a plug-in in the event server service in the management application. This shall allow event-based functionality to be executed without needing to have a user interface open.
   4. It shall be possible to combine and integrate the functionality of one custom-made plug-in with functionality of another custom-made plug-in.
   5. A development framework shall be available that shall facilitate the integration of third-party custom made applications. The framework shall include:
      a. Documentation with application and code samples.

b. A tool box with open access to the video management system provider's libraries and code components for:

i. System logon.

ii. Video decoding and rendering.

iii. Configuration distribution.

iv. Authorization verification.

v. Microsoft Visual Studio® project templates.

vi. A developmental tool for, for example, traces and program logs.

E. The SDK feature shall support integration of video content analytics for event reporting.

1. An analytics event plug-in for the event server shall be available for free download on the website of the video management system provider.

2.13 DOWNLOAD MANAGER

A. A download manager shall be available to assist operators to download various system software applications and/or to upgrade existing software applications on their computers.

B. The download manager must consist of a download manager webpage, and a download manager configuration tool.

C. The download manager welcome webpage shall be generated by the surveillance system server as specified through the download manager configuration tool. When an operator types the IP address of the surveillance system server in a web browser, the download manager shall present the welcome page to the operator with a series of selectable software applications, language options and upgrades. These options shall include:

1. The operators shall be able to download the viewing client and to install it on their PC.

2. The operators shall be able to download additional languages for use on their existing viewing client. Languages included shall be: American English, Arabic, Bulgarian, Simplified Chinese, Traditional Chinese, Czech, Danish, Dutch, Finnish, French, German, Hebrew, Hindi, Hungarian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese (Brazilian), Russian, Spanish, Slovak, Swedish and Turkish.

3. The operators shall be able to run a web viewing client (without installation).

4. The operators shall be able to install add-on applications from the welcome page.

D. The download manager configuration tool shall support configuration of what the download manager welcome page will present to the operators. The configuration tool shall support selection and de-selection of various applications, as well as language packs.

2.14 VIEWING CLIENT

A. The viewing client shall enable operators to connect to the image server for initial authorization. Upon authorization the viewing client shall be able to connect to the recording server(s), for access to video recordings.

B. The viewing client shall provide operators (remote users) with a comprehensive suite of features, including:

1. It shall be possible to view live video from cameras on the surveillance system.
2. It shall be possible to playback recordings from cameras on the surveillance system, with a selection of advanced navigation controls, including an intuitive timeline browser.
3. It shall be possible to create and switch between an unlimited number of views, each able to display video from up to 100 cameras from multiple servers at a time. The system shall make it possible to create views that are only accessible to the operator or to groups of operators.
4. It shall be possible to create special views for widescreen monitors.
5. It shall be possible to use multiple screens as well as floating windows for displaying multiple views simultaneously.
6. It shall be possible to quickly replace one or more of a view's cameras with other cameras.
7. It shall be possible to view images from several cameras in sequence in a single camera position in a designated carousel position.
8. It shall be possible to view video from selected cameras in greater magnification and/or higher quality in a special view position.
9. It shall be possible to receive and send video through a video-sharing functionality or application including live video upon event.
10. It shall be possible to include HTML pages and static images (for example, maps, or photos) in views.
11. It shall be possible to control PTZ cameras.
12. It shall be possible to use digital zoom on live as well as recorded video.
13. It shall be possible to activate manually triggered events.
14. It shall be possible to activate external outputs (e. g. lights and sirens).
15. It shall be possible to use sound notifications for attracting operators' attention to detected motion.
16. It shall be possible to get quick overview of sequences with detected motion.
17. A sequence explorer function shall list thumbnail images representing recorded sequences from an individual camera, all cameras or a subset of cameras in a view.
18. It shall be possible to get quick overview of alarms or events.
19. It shall be possible to quickly search for motion in selected areas of a video recording.
20. It shall be possible to skip gaps (periods with no recordings) during playback of recordings.
21. It shall be possible to configure and use several different joysticks.
22. It shall be possible to print images, with optional comments.

23. It shall be possible to copy images for subsequent pasting into word processors, e-mail, etc.
24. It shall be possible to export recording (for example, for use as evidence) in AVI, JPEG and database formats.
25. It shall be possible to use pre-configured as well as customizable keyboard shortcuts to speed up common actions.
26. It shall be possible to select between language versions of the client, independent of language used on main surveillance system.
27. It shall be possible to communicate with remote audio devices, including microphones and speakers via a local microphone and speaker.
28. It shall be possible to use assigned keyboard shortcuts or joystick buttons to wash and wipe cameras with wash and wipe functionality.
29. It shall be possible to navigate images from 360-degree panoramic fisheye cameras.

C. From the viewing client it shall be possible to adjust the display parameters for the video images (meaning down speed the frames per second, or down sample the resolution) from the recording server to optimize bandwidth utilization.

D. The viewing client shall have the capability to serve as a host to third-party applications through the use of a plug-in component.

E. The viewing client must be installed on remote user's computers.

F. The viewing client shall support a minimum of 20 languages. Each operator shall be able to use a different language based on the downloading of language packages.

G. The viewing client GUI (Graphical User Interface) shall be available in the following language versions: American English, Arabic, Bulgarian, Simplified Chinese, Traditional Chinese, Czech,

Danish, Dutch, Finnish, French, German, Hebrew, Hindi, Hungarian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese (Brazilian), Russian, Spanish, Slovak, Swedish, Thai and Turkish.

H. The viewing client shall support the use of standard PTZ controllers, or three-axis USB joysticks for the control of pan, tilt, zoom and auxiliary camera functions.

I. For efficient review of recorded video the viewing client shall support the use of multimedia control devices that are capable of emulating keystrokes.

J. The viewing client shall support the use of keyboard shortcuts for control of standard features.

K. The viewing client shall have the following two-way audio functions:

1. The viewing client shall enable operators to play live audio and play back recorded audio from microphones.
2. The viewing client shall enable operators to export incoming audio from a camera's microphone together with video in the native database format or as an AVI file.
3. The operator shall have a 'press to talk' option which sends the microphone input from the operator to an IP enabled speaker, or to all speakers.
4. Each camera position shall use the default assigned microphone and speaker, but the operator shall be able to select other audio devices, or keep the same speaker, even when choosing other views.

L. The operator shall be able to use digital zoom where the zooming is performed in the image only. This functionality shall be default for fixed cameras.

M. The viewing client shall include a context-sensitive help system that shall cover the full viewing client functionality so that operators can instantly get help on a certain topic.

N. The viewing client graphical user interface (GUI) shall provide live, playback and setup tabs for the convenient access of live and recorded video as well as camera properties and display quality.

O. The viewing client shall enable the operator to trigger manual events, control outputs, select audio inputs, and control PTZ cameras. The viewing client shall support the following multiple viewing options:

1. It shall be possible to duplicate a selected view as a new floating window and that the window can be moved to other connected monitors by dragging the window.
2. It shall be possible to send views to a primary monitor (a full-screen view on a PC's main monitor), or secondary monitor (a full-screen view on another monitor).
3. It shall be possible to create views consisting of up to 100 cameras each.

4. A carousel feature shall support sequencing display of video from several cameras in a view position. Multiple carousels must be defined to allow all view windows to display sequences of cameras. An operator shall have the ability to select the default display time, or to enter a custom display time for each camera in the carousel. Operators shall have the option to manually switch to the next or previous camera in the carousel camera list, as well as pausing at the current camera. When switching from one camera to the next the transition shall happen completely smooth and without any delay.
5. A feature for viewing enlarged and/or high quality camera video in a view position shall be supported. This special view position feature shall display the camera in the special view position to be viewed in a higher image quality or frame rate than that of the other positions in the view. This feature shall minimize bandwidth utilization by only pulling selected higher quality/higher frame rate of selected images from the recording server. The special view position in the view shall be identified by an orange border.
6. It shall be possible to include cameras on demand or by external events in a view based on the settings regarding video-sharing.
7. Operators shall be able to assign outputs, PTZ presets, events, and change of views as actions connected to joystick buttons and/or keyboard shortcuts. The actions shall be arranged in categories to optimize overview and ease of use.
8. An HTML page feature shall support several navigation functions within the viewing client including:
    a. It shall be possible to open and use WebPages in viewing client views.
    b. It shall be possible to switch between views by clicking on a text description of the view in the HTML page. For example; "Go to Shared Group 1 View 1".
    c. It shall be possible to switch between different views by clicking on an interactive map area. For example; a site or building floor plan with interactive colored zones inserted as a HTML page shall enable the operator to switch views to a camera displaying images of the selected part of the site or building.
    d. It shall be possible to use HTML scripting to create buttons for view navigation.

P. The viewing client shall enable operators to select events and manually trigger the selected event. The event window shall list all events grouped by server and camera/device that the event is associated with.

Q. The viewing client shall support different actions to be taken with a specific camera by right-clicking on the camera's live video. Actions for a specific camera:
    1. It shall be possible to start/stop recording for a predefined number of minutes. This action shall force the system to record, or to stop recording live video, regardless of the settings. The predefined period to start/stop recording shall be configurable by administrators.
    2. It shall be possible to copy a current live image from the camera to the PC clipboard.
    3. It shall be possible to present a menu of available cameras and from this menu shall the operator be able to select a different camera for the given live view position.
    4. It shall be possible to toggle sound notifications between mute and restore upon an event or detected motion.

5. It shall be possible to select a PTZ preset from a list of presets assigned to the specific camera.
6. It shall be possible to manually trigger video-sharing of the live video feed to a video-sharing recipient.
7. It shall be possible to send the camera's live video to a specific position.

R. An output control in the viewing client that shall enable the operator to manually activate an external output port on a device. All selectable outputs shall be listed by the server and the camera/device that the output is attached to.

S. The viewing client shall enable operators to control PTZ cameras within each displayed view, provided that the operators have been granted the proper access rights by the system administrator. Depending on camera capabilities/camera model the typical method for controlling the PTZ functions shall be, as follows: when the mouse cursor is placed inside the view position with video, the cursor pointer shall automatically change to a crosshair indicating that the camera has PTZ capabilities. Centering the camera's field-of-view shall be accomplished by left-clicking the area of interest within the image. Controlling the zoom function shall be accomplished by holding down the left mouse button and selecting a percent zoom from a scale of 0% to 100% or by use of the mouse wheel.

1. Additional control feature for Sony and other PTZ cameras (device dependent) shall include the ability to draw a rectangle around the area of interest to zoom the camera in for closer examination. The size of the rectangle shall be proportionate to the level of zoom, meaning that, the smaller the rectangle the greater the zoom level achieved.

T. The viewing client shall feature PTZ controls that shall provide eight directional move buttons and one home position button.

1. The PTZ control shall provide a digital zoom feature for the operator to digitally zoom in on the displayed image, without affecting the recording, or the display of the camera's video on other viewing client applications.
2. An overview image in the view shall display the normal field-of-view and the digital zoom area in a highlighted box to provide the operator with spatial awareness.
3. The PTZ control window shall enable the operator to select pre-defined presets for PTZ cameras and in this way move the selected camera to the preset.

U. The current camera state shall be displayed on the title bar of each view position, when live video is being viewed. A camera shall indicate that it is in live mode by a green 'Live', in recording mode by a red 'REC' and in stopped mode by a yellow 'Stopped'.

V. A live tab shall via the sequence explorer feature list thumbnail images representing recorded sequences from an individual camera, all cameras or a subset of cameras in a view. The sequence explorer shall be launched in a floating window.

1. The floating window shall make it possible to change between motion, time and event thumbnails.
2. The floating window shall have controls for moving the video forward and backwards in time.
3. When clicking one of the various thumbnails, a preview video of the recorded video shall be displayed.

W. A setup tab shall contain an overview window that shall support viewing set-up layouts with cameras, carrousels, special view positions, HTML pages, static images and the video-sharing feature. The setup tab shall also contain a window that enables camera properties to be set including image quality and frame rate.

X. A setup tab shall enable creation of camera groups and views to be utilized by the live and playback tabs. Camera groups and views must be named according to user requirements. Any combination of the connected cameras shall be displayed in one of the following views.

1. 4 x 3 aspect ratio:
    a. 1 x 1.
    b. 1 + 1.
    c. 1 + 1*.
    d. 1 + 2.
    e. 1 + 2*.
    f. 1 + 1 + 2.
    g. 2 x 2.
    h. 1 + 1 + 4.
    i. 1 + 5.
    j. 2 x 3.
    k. 1 + 7.
    l. 3 x 3.
    m. 2 + 8.
    n. 1 + 11.
    o. 4 x 4.
    p. 4 x 6.
    q. 5 x 5.
    r. 6 x 6.
    s. 7 x 7.
    t. 8 x 8.
    u. 10 x 10.
2. 16 x 9 aspect ratio:
    a. 1 x 2.
    b. 1 x 3.
    c. 1 + 3.
    d. 2 + 1 + 2.
    e. 2 + 4.

f. 3 x 2.

g. 1 + 1 + 6.

h. 1 + 8.

i. 4 x 3.

j. 6 x 3.

k. 12 x 6.

Y. A playback tab shall enable operators to select the views for playback of recorded video. Views shall be defined in the setup tab.

1. The system shall enable live or playback video for a selected camera to switch to full image quality when the camera's view is maximized, unless a 'keep when maximized' function is selected and the stored camera settings are not set to full image quality. If the 'keep when maximized' function is selected, the defined quality settings for the selected camera shall be used.
2. The playback tab shall display sequences with motion for the selected camera in a drop down menu. Each sequence shall be represented by a line with the date, start time and duration. A drop down preview screen shall enable operators to view the recorded sequence.
3. The playback tab shall contain a time navigation pane, which shall enable video sequences for the displayed cameras to be reviewed simultaneously.
   a. The window shall provide controls for:
      i. First/last image.
      ii. Next/previous sequence.
      iii. Next/previous image for selected camera.
      iv. Playback forward/reverse.
      v. Playback speed.
      vi. Skip gaps during playback.
      vii. Search by time/date.
4. The playback tab shall contain an intelligent search feature, which shall allow an area of interest in an image to be searched for motion in a defined time interval. Search parameters shall include sensitivity and interval. A grid feature shall enable that only specific regions of interest are searched.
5. The playback tab shall contain a print feature, which shall enable a surveillance report to be printed with the image from the selected camera including specific information such as camera name, capture time, report print time, operator name and notes (if any). The surveillance report must be printed to any network connected printer.
6. The playback tab shall contain an export feature, which shall enable selection of start and stop times for exporting video from a camera/device source. Possible file formats for the export shall be AVI, MJPEG, or a native database format.

a. The operator shall be able to select the format for the export. Any codec installed on the system shall be selectable. In addition to export format, time stamp, frame rate, and digital zoom export shall be selectable. Video clip must be exported to desktop, or to a specific file path. The audio input from a microphone connected to a camera/device associated with the video being exported shall automatically be included in the AVI export.

b. A native database export function shall support export of up to 16 cameras and shall provide options for including audio associated with the video, security options including compressing and/or encrypting exported database and destination options including desktop, or a specific file path. It shall also include option for a standalone viewing client to be attached to the exported file.

7. A playback tab shall contain PTZ control features, which shall enable digital zoom in recorded video. Using the PTZ control pane's navigation buttons, it shall be possible to use PTZ in the view from a selected fisheye camera.

Z. The playback tab shall via a sequence explorer feature pane be able to list thumbnail images representing recorded sequences from an individual camera, all cameras or a subset of cameras in a view. The sequence explorer shall be launched in a floating window.

1. The floating window shall make it possible to change between motion, time and event thumbnails.

2. The floating window shall have controls for moving forward and backwards in time.

3. When clicking one of the various thumbnails, a preview video of the recorded video shall be displayed.

AA. The playback tab shall contain a timeline browser displaying a time line for each camera to represent recorded video sequences. The sequences shall be color coded to indicate motion detection sequences. For example, a red band shall indicate that the video is recorded because of detected motion, or a green band shall indicate that the recorded video is without motion, or is pre- and post-alarm video. The time line band for the camera selected in the view shall be highlighted in the display.

BB. The system shall enable operators to program numerical keyboard shortcuts for camera views. The shortcut number shall be displayed with the view description in the live and playback tabs. The shortcut shall enable operators to change views with 2 to 3 keyboard entries.

CC. A setup tab shall contain a pane that shall enable the operator to configure the following properties:

1. An image quality setting that shall make it possible to select between: full, super high (for Megapixel cameras), high, medium and low resolution.

2. A keep image quality when maximized setting that, upon maximizing a specific camera image in a full view window pane, shall allow a user to:

3. Use the selected image quality settings for the specified camera,

4. Use the maximum image quality available from the camera device regardless of the image quality settings for the device in the system.

5. A frame rate setting that shall make it possible to select between: unlimited, medium and low frame rate.
6. A maintain image aspect ratio setting that shall enable original image aspect ratio to be maintained in the display or enable the image to be scaled to fit the display.
7. An update image on motion setting that shall enable bandwidth from the recording server to be conserved by only updating the image display on motion.
8. A sound on motion detection setting that shall enable an audible alert to be generated when motion is detected in the camera image to alert operators.
9. A sound on event setting that shall enable an audible alert to be generated upon an event to alert operators.
10. The viewing client application shall be able to run on the following operating system setup:
    a. Microsoft Vista Business/Enterprise/Ultimate, Windows 2003 server, Windows XP Professional, Windows 7 Professional/Enterprise/Ultimate and Windows Server 2008. All as 32-bit or 64-bit applications.

2.15 MOBILE VIEWING CLIENT

A. Access to cameras and views on a mobile device shall be established through three components:
   1. A mobile server that shall be able to run as a dedicated server or on a server running a video management system.
   2. A mobile plug-in that shall integrate with the video management system to provide the necessary configuration for the mobile server to integrate with the relevant video management system.
   3. A mobile client application that shall connect to the cameras and views in the video management system.

B. The mobile device shall connect to the same network as the machine running the mobile server.

C. Mobile server functionality:
   1. The installer for the mobile server shall be available on the website of the video management system provider.
   2. It shall be possible to configure the following elements for the mobile server in the management application/client:
      a. Add a mobile server
      b. Edit a mobile server
      c. Rename a mobile server
      d. Delete a mobile server
   3. View server status, which shall include server status field that shall show:
      a. How long the server has been running since the last time it was stopped
      b. Current CPU usage on the mobile server

c. Current internal bandwidth in use between the mobile server and the relevant recording server

d. Current external bandwidth in use between the mobile device and the mobile server

e. User names of mobile client application users connected to the mobile server

f. Current relation between the mobile server and the mobile client application user

g. Bandwidth usage for a particular mobile client application user

h. Number of currently open live video streams for the relevant mobile client application user

i. Number of currently open playback video streams for the relevant mobile client application user

4. It shall be possible to fill in the following properties for the mobile server in the management application/client:

   a. The name of the mobile server

   b. Description of the mobile server

   c. IP address, which shall be unique for the mobile server

   d. Port number (default port 8081)

   e. The default time frame for how often the mobile client must indicate to the mobile server that it is up and running.

5. Login method

   a. Automatic

   b. Windows only

   c. Basic only

   d. Enable or disable viewing of an all cameras view.

   e. Location of log file

   f. Number of days log files are saved (default value shall be three days)

   g. Default level of CPU usage

   h. Default internal bandwidth usage

   i. Default external bandwidth usage

   j. Default time frame (30 seconds) for checking warning levels

D. Mobile plug-in functionality:

1. The installer for the mobile plug-in shall be available on the website of the video management system provider.

E. Mobile client application functionality:

1. It shall be possible to download and install the mobile client application to a mobile device.

2. The mobile client application shall be available for free download on Google Play (former Android Market) or App Store.
3. The mobile client application shall work with Smartphone's or tablets with Android 2.2+, or iOS5+ or newer installed.
4. The mobile client application shall be able to log into the video management system through the mobile server functionality.
    a. A correct login to the mobile server functionality shall enable the distribution of video streams from relevant recording servers to the mobile client.
    b. It shall not be required to access the internet in order to establish the setup between the mobile client and the mobile server functionality.
    c. It shall be possible to add as many mobile servers as required as long as the user has log-in credentials for these servers.
    d. The mobile client shall use cameras and views already set up in the video management system.
        i. An all-cameras view shall be available for mobile client users that do not have any views set up in the management client/application.
5. The mobile client application shall include the following tabs:
    a. A server tab, displaying the available server and letting users select which server to connect to.
    b. A views tab, displaying displays and previews of available views.
    c. It shall be possible to choose between live and recorded video streams.
    d. A setting tab, displaying user settings and allowing the user to edit to edit relevant settings.
6. Pressing the mobile device's menu button shall display a context sensitive menu that shall include the following items, depending on where in the mobile client application the user is:
    a. Cancel, which shall cancel filter settings on views.
    b. Edit, which shall edit the server settings of the selected server.
    c. Exit, which shall exit full screen
    d. Filter, which shall enable filtering on views.
        i. All views shall be selected by default.
        ii. It shall be possible to clear views that are not needed.
    e. Go to time, which shall open a menu that shall let the user select to view at a specific time in the past.
    f. Help, which shall give access to the mobile client applications online help.
    g. Home, which shall send the user to the list of views in the views tab.
    h. Live, which shall exit playback mode on a selected camera and enter live mode?
    i. New, which shall add and configure a new server?

j. Hide/show live picture-in-picture, which shall turn on/off a small picture-in-picture in live mode.

k. Playback, which shall switch from live to playback mode on a selected camera in playback mode.

l. Playback speed, which shall open a menu with a selection of playback speeds on a selected camera in playback mode.

m. Presets, which shall open a menu with selection of presets for PTZ-cameras on a selected cameras.

n. PTZ, which shall enable a number of PTZ icons on the screen which shall allow you to pan, tilt and zoom in on the current image.

o. Save, which shall save your filtered view(s).

p. Snapshot, which shall take a snapshot of the current frame and save it automatically to an SD card.

7. The servers tab shall allow a user to tap a server to connect to this server and to access the server's context menu.

   a. The context menu for the servers tab shall contain the following settings:

      i. Disconnect a server

      ii. Connect to a server

      iii. Edit server settings for the server

      iv. Delete the server from the mobile client application

   b. It shall be possible to fill in the following details in the server context menu:

      a. Name, where it shall be possible to enter or edit the name of the server.

      b. Address, where it shall be possible to enter or edit the IP address of the computer where the server is running.

      c. Port number, where it shall be possible to edit the port number the mobile client application uses to communicate with the server. The default port number shall be 8081.

      d. Description, where it shall be possible to enter or edit a description for the server.

      e. User name, where it shall be possible to enter a user name.

      f. Password, where it shall be possible to enter a password.

      g. Save credentials, where it shall be possible to save user name and passwords for future usage.

      h. Automatic login, where it shall be possible to select that you want to log in automatically.

8. The views tab shall list the available views in a surveillance setup, as well as the type of view (private, shared, cameras), name and number of cameras.

9. The view tab menu shall contain the following settings:

a. Filter
b. Help
c. Filter views, which shall make it possible to remove any views not needed.
d. Open a view in grid view
e. A filter menu, where it shall be possible to select save or cancel
f. The context menu for the views tab shall contain the following settings:
   i. Save
   ii. Cancel

10. The settings tab shall allow a user to view and/or edit the following settings:
    a. Client version, which shall show the version number of the mobile client application installed on a Smartphone/tablet.
    b. Stay awake, which shall show whether sleep mode is disabled during video streaming or not (both in live and recording mode).
    c. Frames per second, which shall set a frames per second value (between 1 and 30) for transfer of video from the mobile server to the mobile device.
    d. Optimize bandwidth, which shall allow a user to reduce the quality of the images sent to the mobile client to preserve bandwidth.
    e. Auto-hide playback controls, which shall hide icons in the playback navigation bar automatically after a while. Tapping the screen shall make the playback controls reappear.
    f. Auto-hide PTZ controls, which shall hide icons in the playback navigation bar automatically after a while. Tapping the screen shall make the PTZ controls reappear.
11. Opening a view in grid view shall display all relevant cameras in a grid.
    a. All cameras shall contain a red icon that shall indicate motion on the relevant camera when motion is detected.
    b. All cameras shall contain a green icon that shall indicate that video is being recorded every time a new image is received from the camera.
12. It shall be able to view a camera in full screen mode and adjust the image in the following ways:
    a. Use PTZ on PTZ cameras
    b. Zoom in and out (digital zoom) by pinching the screen
    c. Switch between image fitting to screen and image cropped by tapping
    d. View a camera in playback mode
13. Playback mode shall include a navigation bar that shall help users navigate recorded video. The navigator bar shall include:
    a. Buttons always available:
       i. A time-specification button

ii. A set playback speed button

b. Buttons available when playback is stopped:

i. A view previous image button

ii. A forward playback button

iii. A backwards playback button

c. Buttons available when playback is running:

i. A pause playback button

ii. A move to the first image in the next sequence-button

iii. A move to the first image in the previous sequence-button

d. It shall be possible to view picture-in-picture in live mode.

F. A default demo server shall be available in the mobile client application for users to test the mobile client application without having a video management system setup.

1. The demo server shall show random demo content, and it shall not be possible to edit or delete any views, cameras or settings of the demo server.

2.16 WEB VIEWING CLIENT

A. The web viewing client shall offer live viewing of up to 16 cameras and include PTZ control with joystick and event/output activation. Its playback function shall give operators concurrent playback of up to 9 recorded videos with date, sequence or time searching.

B. Support for shared and private server-based views with a layout of up to 4x4 shall be available. Any of these views shall have the ability to contain a combination of cameras, images, and HTML page view items.

C. The web viewing client shall support Basic User Authentication logon using the image server account database which requires user name and password credentials.

D. The web viewing client shall support the following languages: American English, Simplified Chinese, Danish, German, French, Italian, Japanese, Spanish and Swedish.

2.17 STANDALONE VIEWING CLIENT

A. The standalone viewing client shall make it possible to view exported recorded video database files as well as other exported sources:

1. Audio
2. HTML content
3. Images
4. Analytics sources

B. The standalone viewing client shall run from an .exe file, and no installation of software shall be required in order to view exported sources.

C. The standalone viewing client shall share the interface and functionalities of the viewing client and shall be able to run new features developed for the viewing client.

D. The standalone viewing client shall facilitate instant playback of exported material when the program is executed.

E. A project functionality for investigation projects shall exist and allow for:

1. Import of multiple exported sources that can be added to an existing project.
2. Offline creation of new projects.
3. Common tampering and password protection for the exported sources.
4. It shall be possible to export 360° panomorph video recordings for cameras that support this technology for viewing in the standalone viewing client.
5. It shall be possible to export video containing privacy masks, and the privacy mask shall cover the same area as defined in the management application in the standalone viewing client.
6. It shall be possible to define a default export path handled by the surveillance system server. It shall be possible to allow operators to define their own export path in the viewing client by changing settings in the management application.
7. The standalone viewing client shall be available in the following languages: American English, Arabic, Bulgarian, Simplified Chinese, Traditional Chinese, Czech, Danish, Dutch, Finnish, French, German, Hebrew, Hindi, Hungarian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese (Brazilian), Russian, Spanish, Slovak, Swedish and Turkish.

2.18 VIDEO-SHARING APPLICATION

A. The video-sharing application shall support distributed viewing of any camera on the system on any monitor. The system shall offer an option of configuring the video-sharing application viewing client windows as follows:

1. 1x1 view that shall display video feeds from a single camera.
2. 2x2 View that shall display video feeds from up to four cameras. The system shall include options for how the 2x2 view shall be populated.
3. The video feeds must be inserted in top-left to bottom-right order, according to a first-in-first-out principle. Video feeds shall remain in the view until all four positions are used after which any new video feeds shall replace the oldest video feeds.

B. The newest video feed shall always be inserted in the top-left position and any previously received video shall be shifted to the right and down, and finally be 'pushed-out'.

C. The video-sharing application shall access the video stream from the connected camera/hardware device directly, and must not be fed through the recording server.

2.19 TRANSACTIONAL DATA APPLICATION

A. The transactional data application shall enable the operator to search and view transaction data from third-party systems, that is time-linked with video recordings of the relevant transaction activities.

B. The transactional data application shall integrate digital video surveillance images with Point of Sale (POS) or Automated Teller Machine (ATM) transaction data. The application shall enable operators to efficiently answer questions critical to an investigation, such as:

1. If the employee entered the right amount for the product visible on the counter.
2. If all items were scanned at the register.
3. If a returned item were handled properly.
4. If the employee gave an employee discount to a non-employee.
5. The appearance of a customer in case the use of a stolen credit card was reported.

C. The transactional data application shall support integration of ATM or POS transaction data via an open interface supporting a serial server, serial cable or IP connection. The application shall be compatible with any TCP/IP, or serial ASCII data source.

D. The transactional data application shall support creation of views in viewing clients with the transaction data and associated video to be displayed in separate windows.

E. The transactional data application must include a filter that shall enable the user to edit the transaction data and remove unwanted, or unnecessary data from the ATM or POS database.

F. The transactional data application shall enable the user to search for transactions by register/ATM, camera, date, time or free text. All transactional data shall be stored in an SQL database.

G. The transactional data application shall utilize a client/server architecture using HTTP, or TCP directly for communication.

H. The transactional data application shall be supported as a plug-in by the viewing clients.

I. The transactional data application shall be able to run on the following operating system setup:

1. Windows XP Professional or Windows Server 2003.

J. On the client side, the transactional data application shall be able to run on the following operating system setup:

1. Windows XP Professional.

2.20 GRAPHICAL ALARM MANAGEMENT SOLUTION

A. The graphical alarm management solution shall enable continuous monitoring of the operational status and event-triggered alarms from servers, cameras and other devices. The graphical alarm management solution shall provide a real-time overview of alarm status, or technical problems, while it must enable immediate visual verification and troubleshooting.

B. The graphical alarm management solution shall provide interface and navigational controls through the client including:

1. Graphical overview of the operational status and alarms from servers, network cameras and external devices including motion detectors and access control systems.

C. The solution shall provide intuitive alarm management through the use of controls including:

1. Detailed listing of all active or incoming alarms with available filters for time period, alarm source, operator and alarm state.
2. Alarm states must include: new, open, assigned, in progress, processed, resolved, reject, wait, on-hold, ignore, closed, and auto-closed.
3. Ability to reassign alarms to other operators based on: change of state for one, multiple or all alarms, change of alarm priority, entering incident-specific log information and the suppression (snooze function) of alarms.
4. Ability to preview, view live or playback recorded images.
5. Automatically close an alarm based on a corresponding event.
6. Generate audit trail reports by incident.

D. The solution shall provide operations management controls including the ability to:

1. Enable and disable the monitoring of specific servers.
2. Acknowledge or suppress operational status messages for a period of time (for example during scheduled maintenance).

E. The solution shall support system configuration through controls including:

1. Ability to establish connection to servers by DNS name or IP address, and use built-in accounts in legacy systems for server authentication.
2. Trigger alarms by events from servers, cameras or external devices and pre-assign them with priority, operator, optional display of live video on remote monitor and link to related cameras.
3. Supported events like archive failure, camera deleted, external event, motion detected, camera or server responding or not responding, and running out of disk space.
4. Define role-based groups and assign operators to achieve different access rights by type or camera.

F. The solution shall provide interface and navigational controls at the server level including:

1. Client/server based architecture using HTTP and XML for data communication.
2. Support for multiple legacy master/slave servers at multiple remote locations.
3. Central logging of incoming alarms and system information in a SQL database.

G. The solution architecture shall be .NET based with the server component accessed through a client application running on Windows XP Professional or Windows Server 2003 servers.

H. The solution shall include flexible access rights and shall enable each operator to be assigned to several roles, where each operator has uniquely defined access rights to cameras.

I. The graphical alarm management solution application shall be able to run on the following operating system setup.

1. Windows XP Professional or Windows Server 2003.

J. On the client side the graphical alarm management solution application shall be able to run on the following operating system setup.

1. Windows XP Professional.

2.21 DEDICATED SECURITY NETWORK

A. The Video Surveillance and Access Control Systems shall communicate using the existing single mode fiber optic network provided and installed by the communications contractor. There will be no need for the Security Contractor to provide and install any fiber optic and Category 6 cabling infrastructure for video surveillance. The Category 6 horizontal drop provided by the communications contractor is complete from the patch panel in the Telecommunications Room (TR) to the biscuit (or single gang faceplate with modular jacks) installed in the 5S type box at each camera location. The Security Contractor shall provide all required Category 6 patch cords with snag less boot for all security device connections.

B. Typically, the existing single mode fiber optic network topology is a STAR configuration from the Main Distribution Frame (MDF) to the TR's. One fiber optic switch shall aggregate all the fiber optic cables at the head end, and all edge switches located in the TR's shall connect to single mode fibers terminated on the fiber aggregation switch in the head end/MDF.

C. Typically required in the MDF, is an edge switch that will be needed for the connection of local edge devices, cameras, and access control panels/servers/appliances to the dedicated security network. If more than one edge switch is required in any TR (or MDF) to support security devices, all additional switches shall be stacked underneath the primary switch and connected via optical patch cords to the SFP ports via modules. Only one switch per TR can be connected to the fiber optic backbone infrastructure. This group of switches, modules, optical patch cords and existing single mode fiber backbone shall form the dedicated security network.

D. The Design Drawings (Video Surveillance Block/Riser) will indicate all the Telecommunications Rooms (TR) that have switch locations based on the security design. Edge switches will be

deployed only where there are security devices needed, possibly not all TR's will have edge switches in them.

E. Prior to installation, the Security Contractor shall provide and install the newest firmware available from the manufacturer for all switches provided, program all switches with VLAN's, enable Spanning Tree Protocol to inhibit loop connections between switches, and define and configure each switch for Trunking and QoS features to support maximum bandwidth capability.

F. The Security Contractor shall provide the following cyber security measures to restrict unauthorized access to the network switch by changing all factory default passwords to credentials acceptable to ACC, and other security settings which shall be enabled, programmed or configured to provide a minimum of network security as listed;

1. Provide a minimum of two Virtual Local Area Network (VLAN) to support the isolation of data traffic for each of the following data traffic types;
    a. A dedicated VLAN for video surveillance and Access Control together.
    b. A dedicated VLAN for future use.
2. Disable all unused ports.
3. Enable (RJ45) Port Security feature to inhibit the disconnection of the security device and the connection of another device such as a laptop.
4. Disable Front Panel button functions/Enable Front Panel Security features.
5. Change the default password for Administrator account.
6. Change the password for the Console port.
7. Provide an Access Control List based on the IP address of all approved IP devices for the video surveillance and access control systems.

G. The network switch specification is based on Hewlett-Packard 3500/3800 series with expanded services licenses. This is the level of operation and capability to be provided. Alternate acceptable brands are D-LINK SmartSwitch series or COMNET. All switches provided shall have all RJ45

ports a minimum gigabit rated, capable of creating and supporting VLANs and cybersecurity measures.

H. The fiber optic aggregation switch located at the head end (if required) shall be: HP 3800-24SFP-2SFP+ (J9584A). Provide as needed, an SC to LC single mode optical patch cord to connect this switch to the network and other switches.

1. For network connections, the Security Contractor shall determine which SFP module is required based on the length of the single mode fiber run and provide all SFP modules as needed to connect the fiber aggregation switch to all the necessary fiber runs feeding the TR's and the uplink connection to the business network to support remote access viewing of video.

a. For short runs of single mode fiber, provide (one) HP X132 10G SFP+ LC LR Transceiver (J9151A).

b. For longer runs of single mode fiber, provide (one) HP X132 10G SFP+ LC LRM Transceiver (J9152A).

2. Provide (one) HP X410 1U Universal 4 post Rack Mounting Kit (J9583A).

I. The edge switch located in TR rooms shall be: HP 3500-24G-PoE+ yl (J9310A), designed to support 10-Gbps connection via SFP+ Transceivers.

1. For uplink connections of the edge switch to the fiber aggregation switch, the Security Contractor shall determine which SFP module is required based on the length of the single mode fiber run and provide the required SFP module as needed.

a. For short runs of single mode fiber, provide (one) HP X132 10G SFP+ LC LR Transceiver (J9151A).

b. For longer runs of single mode fiber, provide (one) HP X132 10G SFP+ LC LRM Transceiver (J9152A).

2. Provide (one) HP X410 1U Universal 4 post Rack Mounting Kit (J9583A).

3. Provide (one) HP 3500 yl Premium License (J8993A).

4. Provide all required Category 6 patch cords with snagless boot for all security device connections.

5. When more than one 24 port edge switch is need to connect edge devices to the dedicated security network, refer to 2.019, C above.

2.22 VIDEO RECORDING SERVER/STORAGE HARDWARE REQUIREMENTS

A. The server/storage system shall be XVault from Seneca Data, Milestone Husky or Lenel NVR.

1. Server form factor shall be rackmount.

2. Security Contractor shall provide the 3 year, Next Day, On-Site Warranty for all access control servers provided for this project.

3. Recording Server storage shall be sized as specified in 1.6 SUBMITTALS.

4. A minimum of 20% spare storage capacity to support future additional cameras.

5. Recording Server shall support the connection of a local video monitor to access programming and/or view video
6. Server shall be equipped with hardware RAID data protection architecture via SATA, SAS, Hard Disk Drives, or Solid State Drive with MegaRAID or 3ware RAID controller cards to support all direct-attached storage arrays, internal or external.
7. Server shall have a web based GUI interface (XConnect Monitoring Software) designed to monitor, report and manage the overall health, environment and performance of the NVMS server. This web based GUI shall provide;
    a. System Monitoring – provide visual feedback for system issues, environmental characteristics and performance from a single screen.
    b. Immediate Alerts – receive instant notifications for critical issues with the server to take immediate actions, via email notification or SNMP.
    c. Camera Connectivity – Monitor the registered camera on the network to indicate connectivity and status and provide instant notification of lost connection.
    d. Monitor Remotely – Accessible through any Windows based device with access to high level status view of system, storage, network and cameras and provide multiple client versions with enhanced features.

B. The Security Contractor shall provide the following cyber security measures to restrict unauthorized access to the video recording server by changing all factory default passwords to credentials acceptable to ACC.

C. The Security Contractor shall provide and install Category 6 patch cords and connect each server to the dedicated security network.

2.23 MOBILE SERVER HARDWARE REQUIREMENTS (IF REQUIRED)

A. The mobile server is required to have the following capabilities;
    1. 1RU Chassis.
    2. CPU – Pentium 4, 2.4 GHz.
    3. RAM – 8GB RAM
    4. NIC – GB Ethernet interface
    5. Graphics - On board GFX, AGP, or PCI-Express, minimum 1024x768, 16 bit colors
    6. Disk type –Minimum 10GB free space available (when using server-side export additional storage space is needed)
        a. E-IDE, PATA, SATA, SCSI, SAS (7200 RPM or faster)
    7. Operating System – Windows 10 Professional (64 bit).
    8. Software – Microsoft .NET 3.5 or 4.
    9. Direct -X 9.0 or newer.
    10. Windows Help (WinHlp32.exe)

11. Hard Disk space - Minimum 1GB free, excluding space required for recordings

12. XProtect Professional VMS

2.24 IT RACK MOUNTED EQUIPMENT AT SYSTEM HEAD END

A. Provide (1) four port desktop KVM switch for managing all computers supporting access control and video surveillance. The desktop KVM provided shall be an assembly of components capable of USB control and 4K video via (4) DisplayPort connectors.

B. Refer to Design Drawings for details of typical rack mounted configuration. Equipment provided shall be mounted in the rack allotted for security equipment at the system headend.

C. The desktop KVM and accessories shall be rack mounted with at least two components rack shelf mounted. Provide all necessary accessories, cable management, hardware, programming and commissioning of the KVM as part of the video surveillance system.

D. The Security Contractor shall provide the desktop KVM, which shall consist of;

1. (1) 4 port KVM, from VERTIV/Avocent, Model SV300 series.

2. Provide all DisplayPort adapters, USB and video cabling as required. Neatly route, manage and secure all cabling.

3. Miscellaneous hardware to secure desktop KVM to rack shelf.

4. (1) 17" 1080p LCD Rack console, (slide out/lift up keyboard/display), unit shall be Startech.com model RACKCOND17HD.

    a. Disable the fingerprint reader, CCC to use a PIN or Password access to manage the KVM. Coordinate with CCC IT Department for credentials.

5. Provide (1) 2 RU ventilated rack shelf.

2.25 NVMS WORKSTATION

A. The Security Contractor shall provide one mid-tower type workstation to support the Video Surveillance and Access Control systems as a single integrated system. This computer shall share rack shelf space with the desktop KVM.

1. The Security Contractor shall provide a PC workstation with a video card having a minimum of 1GB of dedicated memory and an onboard CPU.

2. Minimum workstation requirements are the following:

    a. CPU-Intel Quad Core Xeon, ES-1600, Series 3.6Ghz

    b. Memory-16 GB

    c. Drives-(1) 500GB SATA-II

    d. Video Card- dedicated CPU with 1 GB RAM of dedicated memory onboard.

    e. Monitor Outputs - minimum of 1 each of either DVI, DisplayPort, or HDMI.

f. Maximum Resolution to be determined by the display(s)

g. Gigabit Network Interface Card

3. Acceptable workstation manufacturers are HP or Dell Precision series.

4. The Security Contractor shall provide the following cyber security measures to restrict unauthorized access to the workstation by changing all factory default passwords to credentials acceptable to CCC.

5. The Security Contractor shall provide and install Category 6 patch cords and connect the PC workstation to the dedicated security network.

2.26 FIELD DEVICES

A. IP Network Cameras – Indoor and Outdoor

1. The IP network cameras shall be: Axis P3364-V (1MP) series for indoor applications.

2. The IP network cameras shall be: Axis Q3505-VE (2.3MP) for outdoor applications. All outdoor cameras shall have lightning and surge protection devices.

3. The Security Contractor shall determine the lens required to support the field of view at installation location of each camera.

4. All IP network cameras shall utilize Power over Ethernet (IEEE 802.3af) except outdoor PTZ's (if required).

5. The Security Contractor shall provide the following cyber security measures to restrict unauthorized access to the video cameras by changing all factory default passwords to credentials acceptable to CCC.

6. The Security Contractor shall provide and install Category 6 patch cords and connect all IP cameras to the dedicated security network.

B. Lightning and Surge Protection

1. All outdoor equipment shall have UL Listed lightning and surge protection devices.

2. Surge protection devices shall be UL Listed from Ditek Corporation.

3. Contractor shall select the device for the application and include it in all required project documentation for approval.

4. Devices shall be installed in approved locations only.

C. IP Camera Housings, Mounts and Accessories

1. All cameras shall be installed with the proper mounting kits for drop tile or hard ceiling types, wall or pole mount, or pendants as indicated. All accessories, mounts and pendant adapters shall be from the manufacturer and support the specified model of camera.

2. Secure all cameras and housings as per manufacturer recommendations appropriate to structural requirements and construction conditions. Utilize tamperproof-mounting hardware.

3. Camera housings installed in ceilings shall have secondary safety attachments to building structure independent of ceiling, fire sprinkler, conduit, or other system supports as per AHJ and applicable codes.
4. For exterior cameras, use appropriate environmentally controlled weather resistant camera enclosures designed for hot and cold climate applications, where temperatures can exceed far above 100ºF and below -20 ºF

D. Elevator Camera System

1. The elevator camera shall be vandal resistant corner-mount type, providing effective performance while incorporating grip-less design for maximum safety.
2. The elevator cameras will all need to utilize the single pair or double pair of traveler cable wiring to transmit their signal to the network. To accomplish this, the use of Network Video Technologies Ethernet over 2-wire transceivers with PoE will need to be used.
    a. There will need to be a transceiver at the camera side (far end) that accepts the CAT6 patch cord from the camera and another transceiver at the opposite end (near end) of the traveler cable that will connect via CAT6 cabling to the network switch via the patch panel in the IDF.
    b. A 56VDC power supply will feed power at the (near end), this transceiver which will then transmit PoE power for the camera side transceiver and the IP camera itself.
3. The Security Contractor shall coordinate with the Elevator Service Company, whom is responsible for all traveler cabling and Elevator Cab hardware rough in and/or installation.

Coordinate with Elevator Service Company to verify whom shall provide installation of the camera system inside of the elevator cab

4. The elevator camera shall be: Bosch model FLEXIDOME IP Corner 9000 MP.
5. The elevator camera power supply shall be provided by the Network Video Technologies NV-EC1701U-KIT1.
6. Video Transceivers shall be Network Video Technologies, model NV-EC1701U-KIT1 which is a kit complete for one device with 2 transceivers and the 56VDC power supply.
7. The Security Contractor shall provide the following cyber security measures to restrict unauthorized access to the video cameras by changing all factory default passwords to credentials acceptable to CCC.
8. The Security Contractor shall provide and install Category 6 patch cords and connect to the dedicated security network.

B. Ethernet Media Converters

1. Media Converters can be deployed to convert a signal to travel on Ethernet compatible media/cable where needed. Many types and applications are available for use and shall be acceptable from Network Video Technologies or Comnet brand.
2. Security Contractor shall select the devices for use and submit Data Sheets for approval of all devices and shall show them in the Shop Drawing package where used at all locations.

C. Ethernet Extenders

1. Any camera or IP device that will have a cabling length of more than 300 feet will require and Ethernet extender.
2. Ethernet extenders shall be placed in approved locations when used. Devices shall not be hidden in locations that cannot be easily access or maintained with certain ease.
3. Security Contractor shall select the devices for use and submit Data Sheets for approval of all devices and shall show them in the Shop Drawing package where used at all locations.
4. Devices from Veracity Outreach Max family of products shall be approved, no substitutions permitted.

2.27 WIRE AND CABLE

D. The Security Contractor shall provide and install all fiber optic patch cords for switch connections to the dedicated security network.

E. Except as specifically noted to the contrary herein, all primary camera cabling shall be unshielded twisted pair (UTP) Category-6, which is the CCC IT/telecom UTP cable standard. This cabling shall be provided by the selected project low-voltage IT/telecom cabling contractor and shall not be part of the Security Contractor's scope.

F. Unless specifically noted to the contrary on Security drawings, all cable runs for security cameras shall be one (1) Category-6 unshielded twisted pair (Cat-6 UTP) cable to each camera location terminated in a Cat-6 RJ-45 modular female jacks at the camera location. The Demark for the Security Contractor shall be the RJ45 female jack at the camera. Cat-6 UTP cables (provided by others) shall be terminated in the appropriate TR on Cat-6 patch panels provided by others.

G. At the TR end of each UTP cable, it shall be the responsibility of the Security Contractor to provide a CAT-6 patch cord and make all connections from the Cat-6 patch panels to the respective security equipment/systems. Such work shall be coordinated in advance with CCC IT and all CCC IT standards and practices for such work shall be adhered to.

H. At the security device end of each UTP cable, it shall be the responsibility of the Security Contractor to provide and install a Cat-6 UTP patch cord and make the connections from the Cat-6 female jack to the camera. Such work shall be coordinated in advance with CCC IT and all IT standards and practices for such work shall be adhered to

I. Specific Cat-6 UTP cabling information shall be referenced in Division 27 Specifications for low-voltage cabling for brand, make, model and acceptable patch cord installation standards including labeling.

J. Use of Velcro cable management is specified. Use of tie wraps for cable bundle management is not permitted.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Systems shall be complete and operational in all respects.

B. The Contractor shall furnish and install all equipment necessary to build the Integrated Security System as referenced herein.

C. All wall, floor, and ceiling penetrations, regardless of fire rating, must be properly sleeved with conduit and properly sealed using approved fire stopping materials and sealants, according to CCC standards.

D. All security equipment, junction boxes, terminal cans, etc. installed in public accessible areas shall be installed utilizing tamper proof mounting hardware. Contractor shall provide a minimum of 2 driver bits or hand tools for each type and size of security fastener provided.

E. The Contractor shall provide seismic restraint for all equipment, including equipment racks, consoles, etc.

3.2 PROGRAMMING

A. Contractor shall provide initial programming for all applicable systems. Contractor programming shall include, but not be limited to:

1. English-language description of each alarm location.

2. Programming of the head-end equipment.
3. Programming of Video Management Software.

B. Submit to CCC for the review of the proposed programming, including device names and descriptions, timings, sequence of operations, etc.

C. Upon CCC's request, the Contractor shall reprogram each system one time during the Warranty Period at no additional cost. At no additional charge, the Contractor shall update the system software to the most recent version available at the time of the reprogram.

3.3 TESTS AND REPORTS

A. The Contractor shall perform system tests using personnel who have attended a manufacturer's training school for installation and testing of the systems as described herein. The Contractor shall perform testing with the test instruments as specified/directed by the manufacturer. Testing by means other than the manufacturer's procedures will not be acceptable unless agreed to in advance in writing by ACC, Security Consultant and the equipment manufacturer.

B. Upon completion of the installation of the Security Systems, the Contractor shall submit written reports including, but not limited to, the following information:

1. A complete list of all equipment installed, including serial numbers of major components.
2. Certification that all equipment is properly installed, programmed, functional, 100% operational, and in conformance with contract Specifications and Drawings.
3. Test reports of all connected devices and equipment, including IP addresses, device Id's and test results indicating pass/fail of device operation.
4. Test technician's name, company and date of test.

C. Following review of the test report(s) by CCC, the Contractor shall perform a test of Security System equipment in the presence of CCC and the Consultant. Test(s) shall include performance tests of all equipment and material required by the contract. The Contractor shall be responsible for all additional costs to CCC if retesting is required. At a minimum, perform tests to demonstrate that:

1. All systems are free from grounding problems and open circuits.
2. Systems operate properly on battery backup.
3. All software functions properly as specified, and all equipment is fully programmed.
4. The Security Contractor shall disable all unused ports of all switches deployed in the dedicated security network. Provide and submit a written Test Report that indicates all the unused ports are disabled. This test report shall be available at time of demonstration of Final Acceptance.

D. Sixty days prior to expiration of Warranty, Contractor shall retest all systems as described herein, and submit a test report of findings. All items covered by Warranty shall be corrected

immediately. The Warranty shall remain in effect until the Contractor corrects 100% of defective items.

3.4 COMMISSIONING

A. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

B. Contractor shall submit a request for the Acceptance test in writing to the Security Consultant no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.

C. During Acceptance test, Contractor shall demonstrate all equipment and system features to Security Consultant and an Owner's Representative. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by Security Consultant and the Owner's Representative.

D. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. The Security Consultant will prepare a list of any such deficiencies observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to the Security Consultant for another Acceptance Test.

E. If, at the conclusion of the Acceptance Test, all Work is found to be acceptable and in compliance with the Project Drawings and Specifications, The Security Consultant will issue a letter of Acceptance to Contractor and the Owner's Representative.

3.5 AS-BUILT DRAWINGS

A. The Contractor shall maintain a complete set of CCC Approved Shop Drawings on-site as the work on the Access Control System is being completed. As work is installed, Contractor shall carefully draw on prints the correct location of work including all critical dimensions.

B. Upon completion of the project, Contractor shall transfer hand-drawn information to CAD Drawings, updated CAD disks, and submit to CCC for review. No hand-drawn as-built drawings shall be accepted.

C. The Contractor shall provide four (4) sets of As-built Drawings, plus one (1) set of CAD disks, to CCC. One (1) additional complete set shall remain on the job site in folders secured on the wall adjacent to the control panels.

3.6 TRAINING AND OPERATION/MAINTENANCE MANUALS

A. The Contractor shall provide a minimum of four (4) copies of Operation and Maintenance manuals for all equipment furnished under the Security Systems sub-sections. These manuals are to be available during training.

B. The Operation and Maintenance manuals shall include the following information and full procedures for;

1. Database back-ups.
2. Server/workstation hard drive maintenance, such as defrag, drive and RAM memory replacement, etc.
3. Maintaining physical and software firewalls.
4. Upgrading any software used in the system.
5. Testing battery condition on all field panels for adequate back-up time.
6. Any other tasks that must be performed to ensure the warranty remains intact.

C. Provide a minimum of eight (8) hours of scheduled training for the equipment furnished under this Section, including programming, operation, service, and maintenance.

D. Training shall be by engineers or technicians highly skilled in the systems and certified by manufacturer as qualified to train in the particular systems.

E. Training shall be conducted at dates and times directed by CCC's representative. Training shall be provided for all security staff personnel and system end-users.

F. CCC, prior to release of retention compensation, shall require verification of completion of training.

3.7 IT REQUIREMENTS

A. The Security Contractor shall coordinate with the IT department (IT) for all network and telecom connections to keep within the level and consistency of workmanship quality, materials selection and installation methods for all work performed in any Telecommunications Room (TR).

B. Security Contractor shall request an IP address table from the IT department (IT) for all devices requiring an IP address. The address table must be approved prior to deploying and programming devices and a Report submitted for review at demonstration of Final Acceptance.

C. Refer to Section 3.03 Tests and Reports for further information.

END OF SECTION

SECTION 312000 - EARTHWORK

PART 1 GENERAL

1.1 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. Preparing and grading subgrades for slabs-on-grade, walks, pavements and landscaping
2. Excavating and backfilling for buildings and structures.
3. Drainage and moisture-control fill course for concrete slabs-on-grade.
4. Base course for concrete walks, asphalt and pavements.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling trenches for utilities and appurtenances outside building lines.

B. Related Sections:
1. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities.
2. Division 03 Section "Cast-in-Place Concrete" for granular course beneath the slab-on-grade.
3. Division 31 Section "Site Clearing" for site stripping, grubbing, and removal of above- and below-grade improvements and utilities.
4. Division 33 Section "Subdrainage" for drainage of retaining and planter walls.

1.3 REFERENCE SPECIFICATION

A. Perform all work in accordance with applicable provisions of "Standard Specifications for Public Works Construction", 2012 Edition, and UBC and 2013 CBC. Unless otherwise noted, mention herein of section numbers refers to sections of the Reference Specification. Where Reference Specification refers to "Agency", substitute the word "Owner". Where Reference Specification refers to "Engineer", substitute the word "Architect". Where Reference Specification is in conflict with these Specifications, these Specifications shall govern.

B. The recommendations found in the Geotechnical Engineering and Geologic Hazards Study prepared by Heider Inspection Group dated December 21, 2015, apply to this Section.

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and the surface pavement in paving system.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill when sufficient approved soil material is not available from excavations. Import soils must be tested and approved prior to delivery to the site.

E. Drainage Fill: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered to subgrade elevations and the re-use or disposal of materials removed.
   1. Authorized Additional Excavation: Excavation below subgrade elevations as directed by Architect.
   2. Unauthorized Excavation: Excavation below subgrade elevations without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

L. Compaction: Any method of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum dry density obtained by the test procedure described in ASTM D 1557 for general soil types abbreviated in this Specification as 90 percent of maximum dry density".

M. Hard Material: Weathered rock, dense consolidated deposits or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal

N. Lift: A layer or course of soil placed on top of previously prepared or placed soil in a fill or embankment.

O. Unsatisfactory Material: Soil or other material identified as having insufficient strength or stability to carry intended loads without excessive consolidation or loss of stability.

1.5 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Warning Tape
   2. Geotextile
   3. Water Quality Filter Media

B. Location of Borrow Materials.

C. Material Test Reports

D. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.
   1. Pre-excavation photographs of existing retaining wall along the west side of the property.

1.6 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction

B. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing.

C. Pre-excavation Conference: Before commencing earthwork, meet with representatives of the governing authorities, Owner, Architect, consultants, Geotechnical Engineer, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least 3 working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided.
   1. Provide a minimum 48-hours notice to the Architect and receive written notice to proceed before interrupting any utility.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies and owner to shutoff services if lines are active.

C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

D. Utility Locator Service: Notify UNDERGROUND SERVICE ALERT for area where Project is located before beginning earth moving operations.

E. Do not commence earth moving operations until temporary erosion/sedimentation control measures, specified in Division 01 are in place.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil materials imported or excavated on the property determined to be suitable as referenced in the project Geotechnical Investigation Report; and approved by the Geotechnical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.
   1. Refer to Geotechnical Investigation Report, for unsuitable materials and disposal methods for unsatisfactory soils.

D. Backfill and Fill Materials: Satisfactory soil materials.

E. Base Material: Shall conform to crushed aggregate base or crushed miscellaneous base, as specified on plan, in accordance with section 200-2.2 or 200-2.4, respectively, of the Reference Specification, and compacted to at least 95% of the maximum dry density as determined by ASTM Test Method D 1557.

F. Engineered Fill: Base Materials and compacted fill materials

G. Bedding Material: Shall be base materials with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve; or clean sand classified in accordance with ASTM D 2487.

H. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate grading size 57, with 100 percent passing a 1-1/2-inch sieve and not more than 5 percent passing a No. 8 sieve

I. Filtering Material: Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 50 sieve.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf (700 N); ASTM D 4632.
3. Sewn Seam Strength: 142 lbf (630 N); ASTM D 4632.
4. Tear Strength: 56 lbf (250 N); ASTM D 4533.
5. Puncture Strength: 56 lbf (250 N); ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.2 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.
   6. White: Steam systems

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.
   6. White: Steam Systems

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Tree protection is specified in the Section 311000 "Site Clearing". Refer to landscape architectural plans for instructions.

D. Prepare subgrade and place base materials in accordance with sections 301-1.2 and 301-2, respectively, of the Reference Specification.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Dewatering shall be done in accordance with NPDES waste discharge requirements. Contractor shall obtain all necessary Dewatering permits from state and local jurisdictions.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. General: Excavation shall be to the contours, elevations and dimensions indicated. Keep excavations free from water and debris while construction is in progress. Notify the Owner immediately in writing where it becomes necessary to remove hard, soft, weak, or wet material to a depth greater than indicated. Unless otherwise indicated, concrete placed below grade will be formed and excavations shall allow for placement and removal of forms. Side cuts shall be cribbed and shored as required.

B. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions as described in the referenced Geotechnical Investigations Report.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials, replace with satisfactory soil materials.
   2. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and rocks.
   3. Rock fragments greater than 3 inches in diameter shall be taken off-site, or placed in accordance with the recommendations of the Geotechnical Engineer in areas designated as suitable for rock disposal.

3.5 STABILITY OF EXCAVATIONS

A. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

B. Unshored Temporary Excavations:
   1. Unshored temporary excavations may be sloped back at 1.5 to 1 (horizontal to vertical) or flatter up to 5 feet in height. Where sloped embankments are used, the tops of the slopes should be barricaded to prevent vehicles and storage loads within seven feet of the tops of the slopes. If the temporary construction slopes will be maintained during

the rainy season, construct berms along the tops of the slopes where necessary to prevent run-off water from entering the excavation and eroding the slope faces.

3.6 EXCAVATION FOR STRUCTURES

A. Excavation Limits: Shall be to a tolerance of plus-or-minus 0.10 foot and shall extend five (5) feet laterally beyond the building limits at the excavation level and five (5) feet below the structural mat foundation, or deeper to excavate existing fill. The excavation side slopes shall not exceed a slope ratio of 1.5 to 1, horizontal to vertical, up to 5 feet in height, unless they are positively retained by shoring or other approved methods. Over-excavation side slopes may be vertical, as long as they are no higher than allowed by the State of California Construction Safety Orders, in which case they shall be no steeper than 1.5 to 1. If cut below depths indicated, excavations shall be filled with concrete when the foundations or footings are placed. Revise first subparagraph below if footings and foundations are placed on engineered fill.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
   1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.7 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.8 EXCAVATION FOR UTILITY TRENCHES

A. Excavation made with power-driven equipment is not permitted within five feet of any known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, use hand or light equipment excavation. Start hand or light equipment excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines and other existing work affected by the excavation work of this Section until approval for backfill is granted by the geotechnical engineer. Immediately report damage to utility lines or subsurface construction to the Owner.

B. Where unidentified existing utilities are encountered, determine whether these are active or abandoned. Remove interfering portions of abandoned utilities and cap or plug open ends of pipe to remain. The cap or plug must seal the opening in such a manner that would permit remaining portions of the utility to be reactivated. Notify Owner for instructions on utilities which are determined to be active. Do not proceed without instructions, except to correct an immediate hazard or emergency condition. Relocation work performed on an

active utility without obtaining prior approval from Owner shall be done at the Contractor's expense and liability.

C. In areas where compacted backfill has been placed, additional consolidation may occur after completion due to changes in moisture content and surcharge. Utility connections crossing this backfill, and improvements adjoining the building at the backfill line shall be installed taking into account this additional consolidation, or sufficient time shall be scheduled between backfilling operations and such improvements to allow this consolidation to take place. Damage to utilities or other improvements due to Contractor's negligence in regard to this paragraph shall be repaired at the Contractor's expense

D. Protect newly backfilled areas and adjacent structures, slopes, or grades from traffic, erosion settlement, and any other damage. Repair and re-establish damaged or eroded grades and slopes and restore surface construction prior to acceptance

E. Cutting Pavement, Curbs, and Gutters: Saw cut with neat, parallel, straight lines one foot wider than trench width on each side of trenches and one foot beyond each edge of pits. If an existing pavement joint or cracked area is within two feet outside of a designated sawcut line shown on the Drawings, removal and resurfacing shall be to that joint, and/or shall include the crack or cracked area, unless otherwise approved by Architect.

F. Contractor shall pothole at all identifiable crossings of existing utilities prior to any trenching operations and provide Architect with a survey of the top elevations (and bottom elevations, if applicable), of possible interferences so that an evaluation of necessary adjustments to the current profile or alignment may be made. Additionally, Architect shall be given the opportunity to view possible conflicts in the field prior to providing revised designs.

G. Provide a minimum cover from grade of 3 feet for water mains and gas mains. Storm drains and sewers shall be to the depths indicated. Where settlements greater than the tolerance allowed herein for grading occur in trenches and pits due to improper compaction, excavate to the depth necessary to rectify the problem, then backfill and compact the excavation as specified herein and restore the surface to the required elevation.

H. Keep excavations free from water while construction is in progress.

I. Notify the Owner immediately in writing if it becomes necessary to remove rock or hard, unstable, or otherwise unsatisfactory material to a depth greater than indicated. Excavate large rock, boulders, and other unyielding material to an overdepth at least 6 inches below the bottom of the pipe, conduit, duct and appurtenances, unless otherwise indicated or specified. Over-excavate soft, weak, or wet excavations to an overdepth at least 6 inches below the bottom of the pipe, conduit, duct or appurtenances unless otherwise indicated or specified.

J. Excavate trenches to indicated slopes, lines, depths, and invert elevations.

K. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, except where sloping of sides is allowed. Sides of trenches shall not be

sloped from the bottom of the trench up to the elevation of the top of the pipe. See plans for detail.

L. At the option of the Contractor, the excavations may be cut to an overdepth of not less than 4 inches and refilled to required grade as specified.

M. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.
   1. For pipes or conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
   3. Dig bell holes and depressions for joints after trench has been graded. Dimension of bell holes shall be as required for properly making the particular type of joint to ensure that the bell does not bear on the bottom of the excavation.

3.9 APPROVAL OF SUBGRADE

A. Notify Architect when excavations have reached required subgrade.

B. If and when Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired roller to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
   2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Unforeseen additional excavation and replacement material will be paid for according to Contract provisions for Changes in Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.10 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to the Architect.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 SOIL TREATMENT

A. All chemical applications used for soil treatment are subject to the approval of the Owner.

B. Recommended termiticide: Chlorpyrifos " Dursban TC", or Permetrin "Torpedo" or "Dragnet", or district approved equal.

C. Do not apply soil treatment solution until excavating, filling and grading operations are completed and prior to any membrane being placed beginning concrete placement or other construction activities.

D. To ensure penetration, do not apply soil treatment to excessively wet soils or during inclement weather. Comply with handling and application instruction of soil toxicant manufacturer.

E. Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under foundations.

F. Apply soil treatment solution at rates recommended by soil toxicant manufacturer.

G. Allow not less than 12 hours for drying after application, before beginning concrete placement or other construction activities

H. Reapply soil treatment solution to areas disturbed by subsequent excavation or other construction activities following application.

3.13 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Acceptance of construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.14 UTILITY TRENCH BACKFILL AND COMPACTION

A. Backfilling of exterior utility trenches shall not be undertaken until geotechnical engineer has received 24-hours notice, until required tests and inspections have been completed, and until as-built location notes have been furnished. Remove uninspected backfill in accordance with requirements of this specification. Use hand-operated, plate-type, vibratory, or other suitable hand tampers in areas not accessible to larger rollers or compactors. Avoid damaging pipes and protective pipe coatings.

B. Place backfill material in accordance with Section 306-1.3.2 of the Reference Specifications and achieve at least 90% of the maximum density. The top 12 inches of backfill in the building or paved areas shall be compacted to 90% of maximum density.

C. Compaction by ponding or flooding will not be permitted.

D. Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

E. Concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches of footings. Place concrete to level of bottom of footings

F. Provide 4-inch-thick concrete base slab support for piping or conduit less than 2'-6" below surface of roadways. After installation and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway base.

G. Place and compact initial backfill of satisfactory soil material or base material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit.
   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

3.15 FILL

A. Preparation: Scarify and remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.
   1. The scarified ground shall be brought to optimum moisture, mixed as required, and compacted as specified. If the scarified zone is greater than 12 inches in depth, the excess shall be removed and placed in lifts restricted to six inches.
   2. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use base materials
   4. Under building slabs, use base materials
   5. Under footings and foundations, use drainage fill materials.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.16 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
      a. Stockpile or spread and dry removed wet satisfactory soil material.

3.17 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Keep rollers and other heavy equipment at least 18 inches from footings, foundations, piers and walls of buildings and accessory construction. Use mechanical and hand tampers weighing at least 90 pounds with a maximum face area of 48 inches square to compact backfill within 18 inches of construction and where access is restricted.

C. Percentage of Maximum Dry Density Requirements: Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
   1. For general site fills, compact each layer of backfill or fill material at 90 percent maximum dry density.
   2. Under structures and building slabs, provide engineered fill layer per plans and geotechnical report compacted to 90 ~~95~~ percent maximum dry density.
   3. Under walkways and paving, scarify and recompact top 12 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent maximum dry density.
   4. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent maximum dry density.

3.18 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
   3. If necessary, the Contractor's selected equipment and construction procedure shall be altered, changed or modified in order to meet the specified compaction requirements. Flooding and water jetting is prohibited.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Lawn or Unpaved Areas: Plus or minus 0.10 foot, unless otherwise indicated.

2. Concrete Walks: Plus or minus 0.025 foot.
3. Pavements:
   a. Concrete: 0.025 foot minus, with no high spots.
   b. Asphalt: 0.05 foot minus, with no high spots.

C. Grading inside Building Lines: Finish subgrade to a tolerance of ½ inch when tested with a 10-foot straightedge.

3.19 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 33 Section "Storm Drainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches x12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
   1. Compact each filter material layer to 90 percent of maximum dry unit weight

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
   1. Compact each filter material layer to 90 percent of maximum dry unit weight
   2. Place and compact impervious fill over drainage backfill in 6-inch thick compacted layers to final subgrade.

3.20 BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements and walks as follows:
   1. Compact base courses at optimum moisture content to required grades, lines, cross sections and thickness to not less than 95 percent of ASTM D 4254 relative density.
   2. Shape base to required crown elevations and cross-slope grades.
   3. When thickness of compacted base course is 6 inches or less, place materials in a single layer.
   4. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

3.21 PAVEMENT REPAIR

A. Repair or patch asphalt pavement as specified in Section 321216 ASPHALTIC PAVING. Repair or patch concrete pavement, curbs and gutters as specified in Section 321313 CONCRETE PAVING. Do not repair pavement until trench has been backfilled and compacted as herein specified. As a minimum, maintain one-way traffic on roads and streets crossed by trenches.

3.22 FIELD QUALITY CONTROL

A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.
   1. Perform field in-place density tests according to ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2937 (drive cylinder method), as applicable.
      a. Field in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.
      b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.

B. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

C. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

D. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.

E. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet or less of trench, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.23 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact at optimum moisture content to the required density.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.24 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

END OF SECTION

SECTION 312219 - FINISH GRADING

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:
   1. Weeding.
   2. Finish grading of lawn and planting areas.

B. Related Sections include the following:
   1. 32 90 00 Section: Landscape Planting
   2. 32 80 00: Irrigation System
   3. 31 20 00: Earthwork

1.3 DEFINITIONS

A. Finish grading: finish grading shall consist of adjusting and finishing soil surfaces with site or imported topsoil, raking grades to a smooth, even, uniform plane. Remove and legally dispose of all extraneous matter off site. Facilitate natural run-off water and establish grades and drainage indicated as part of the contract work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil:
   1. Refer to Section 32; Landscape Planting.

B. Obtain imported topsoil from approved local sources. Import Soils must be tested and approved prior to delivery to the site.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Prior to commencing the finish grading, review the installed work of other trades and verify that their work is complete.
   1. Rough Grading: Grading in planting areas (except raised planter areas) shall be established to within plus or minus 0.10 foot prior to beginning of finish grading.

B. Import topsoil only when necessary to supplement site soil to achieve grades shown on drawings, or if site soil is unsuitable for planting.

3.2 PREPARATION

A. Weeding: Before finish grading, weeds and grasses shall be dug out by the root or sprayed with an herbicide and disposed of off-site. This procedure is outlined under the Landscape Planting Section.

B. Debris: Remove stones and debris 1 inch in diameter and greater and clumps of earth that do not break up. Dispose of off-site.

3.3 INSTALLATION

A. General: When rough grading and weeding have been completed, and the soil has dried sufficiently to be readily worked, lawn and planting areas shall be graded to the elevations indicated on the Drawings.

1. Grades indicated on Drawing are grades that will result after thorough settlement and compaction of the soil.

2. Grades not otherwise indicated shall be uniform finish grades and, if required, shall be made at the direction of the Architect.

3. Finish grades shall be smooth, even, and a uniform plane with no abrupt change of surfaces.

4. Soil areas adjacent to buildings shall slope away from the building to allow a natural run-off of water, and surface drainage shall be directed as indicated on the drawings by remodeling surfaces to facilitate the run off water at 2% minimum grade.

5. Low spots and pockets shall be graded to drain properly.

B. Drainage: Finish grade with proper slope to drains.

1. Flow lines, designated or not, shall be graded and maintained to allow free flow of surface water.

2. If any drainage problems arise during construction period due to Contractor's work (such as, but not limited to, low spots, slides, gullies and general erosion), the Contractor shall be responsible for repairing these areas to a condition equal to their original condition, and in so doing shall prevent further drainage problems from occurring.

C. Toe of slope: To prevent soil creep or erosion across pavement, where pavement (walk, curb, etc.) is at the toe of a slope, finish grade is to level out or swale slightly at least 6" before reaching pavement.

D. Moisture Content: The soil shall not be worked when the moisture content is so great that excessive compaction occurs, nor when it is so dry that dust may form in the air or that clods do not break readily. Water may be applied, if necessary, to provide moisture content

for tilling and planting operations. It is the Contractor's responsibility to control dust that is spread as a result of grading operations.

E. Grades: The finish grade in areas to be planted with turf shall be 2- inches below grade of adjacent pavement and walks.

F. Compaction: Soils in planted areas shall be loose and friable, yet firm enough that no settling occurs from normal foot traffic or irrigation.

3.4 FIELD OBSERVATION

A. It is the Contractor's responsibility to contact the Architect 48 hours or two working days in advance of each agreed observation or conference.

B. Schedule for On-Site Reviews: at completion of finish grading and prior to any planting operations.

END OF SECTION

SECTION 320190 - LANDSCAPE MAINTENANCE

PART 1 GENERAL

1.01 DESCRIPTION

A. Landscape Maintenance.
   1. Establish all plantings and perform landscape maintenance as specified herein for a period of 90 days. The maintenance period shall begin when substantial completion of the landscaping installation for the entire project has been approved by the Owner.

B. Related work specified elsewhere.
   1. Landscape Irrigation. (328000)
   2. Landscape Planting. (329000)

1.02 SUBMITTALS: Refer to Section 013300 for procedures

A. Maintenance Schedule.
   1. Before being placed on maintenance, the Contractor shall submit a schedule of all activities planned during the maintenance period. This shall be approved by the Owner prior to the start of maintenance. Schedule changes shall be documented and approved by the Owner whenever occurring.
   2. Maintenance Materials Record:
      a. Contractor shall record on a daily basis and submit a monthly record of all herbicides, insecticides, and disease control chemicals used in maintenance.

B. Maintenance Record.
   1. Contractor shall continuously maintain all landscape areas during landscaping installation, during the maintenance period, and until final acceptance of the entire Work by the Owner.
   2. Improper maintenance or possible poor condition of any planting at the end of scheduled maintenance period may delay substantial completion date of the Work. The maintenance period will be extended if the maintenance requirements indicated and specified are not fulfilled by the Contractor, at no extra cost to the Owner.
   3. The Contractor shall request an inspection to begin the plant maintenance period after all planting and related work has been completed in accordance with contract documents. One prime requirement is that all groundcover areas be planted.
   4. Maintenance period will not start until all elements of the landscape planting, irrigation, and related items for the entire work are complete. When all the landscaping and related work are completed and approved by the Owner, after the pre-maintenance inspection, a field notification request will be issued by the Contractor to the Owner to establish the effective starting date of the

maintenance period.

5. Any plants found to be dead, missing, or in poor condition during the maintenance period shall be replaced immediately by the Contractor. The Owner shall be the sole judge as to the condition of material and the quality and condition of replacement plants.

D. Warranty
   1. Landscape plant materials shall be warranted against dead or dying, poor, inadequate, or inferior materials and/or workmanship for the specified periods from date of final acceptance of the work. All plants found to be dead, undersized or in poor condition during warranty periods, as determined by the Owner, shall be promptly replaced by the Contractor with approved plant material at no cost to the Owner. Plant materials, including trees, shall be warranted for one year.

E. Prerequisites To Final Acceptance
   1. Prior to Landscaping walk-through inspection, Contractor shall have prepared and submitted record drawings and controller charts for all irrigation work.

F. Materials
   1. Materials used for work of this Section shall either conform to Section 329000 and 328000 or shall otherwise be approved.

G. Maintenance Procedure
   1. Landscaped areas shall be kept free of debris and planted areas shall be weeded and cultivated at intervals of not more than ten days. Watering trimming, fertilizing, spraying, and pest control, as required, shall be included in the maintenance period. Contractor shall maintain adequate protection of the landscaped areas. All damaged areas shall be repaired at the Contractor's expense.

H. Tree and Shrub Care
   1. Maintain a large enough water basin around the plants so enough water can be applied to establish moisture throughout the major root zone. When hand watering, use a water wand to break the water force. Use mulches to reduce evaporation and frequency of watering.
   2. Remove stakes as soon as they are no longer needed. Inspect stakes to prevent girdling of trunks or branches and to prevent rubbing that causes bark wounds. Replace all broken stakes and ties with specified materials.
   3. Prune to shape all new trees as directed by the Owner.
   4. Keep watering basins and the areas between the plants free from weeds. Use recommended legally approved herbicides. Avoid frequent soil cultivation that destroys shallow roots. Use mulches to help prevent weed seed germination.
   5. Maintain control of insects, rodents and disease with materials approved by the EPA and all other governing authorities.
   6. Fertilize all planting areas with amendments as specified by the soils report.
   7. Replace dead, dying, diseased, and missing plants and plants not showing acceptable habit of growth and approved size, condition, and variety of plants at the Contractor's expense.

I. Groundcover Care

1. Remove trash weekly. Replace dead or missing plants at Contractor's expense.
2. Control weeds with chemical systemic spray or by mechanical means so as to cause no damage to planted materials.
3. Fertilize as specified under "Tree and Shrub Care" above.
4. Edge around cover to keep plants in bounds and trim top growth as necessary to achieve as overall even appearance.

J. Lawn Area
1. Mow grass to 2"-3" height whenever growing to a 3-1/2" height. Promptly re-sod any areas not showing full establishment or damaged by flowing water or other cause. Apply top dress fertilizer as specified under "Tree and Shrub Care" above.

K. Irrigation System
1. Contractor shall check weekly all irrigation systems for proper operation. Lateral lines shall be flushed out after removing last sprinkler head or two at each end of the lateral. All heads shall be adjusted as necessary for unimpeded coverage and to minimize overspray on hard surfaces. Hand water as needed until roots of all plantings reach subsurface irrigation.
2. Set and program existing automatic controllers for seasonal water requirements Give Owner a key to controllers and written instructions on how to turn off system in case of emergency.
3. Contractor shall repair all damage to the irrigation system at Contractor's expense. Repairs to be made within one watering period.

L. Inspections
1. When inspections are required, Notify Owner at least 3 working days in advance of the time of inspection.
    a. Required Maintenance Inspections – As Follows:
        1) Pre-maintenance inspection
        2) At the end of the first 30 calendar days during maintenance period.
        3) At the end of the second 30 calendar days during maintenance period.
        4) Walk-through inspection 10 days prior to end of maintenance period.
        5) At the completion of the maintenance period, after all deficiencies disclosed by inspections during the maintenance period are corrected, a final inspection is required for approval of landscape.

END OF SECTION 320190

SECTION 321216 - ASPHALT PAVING

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:
   1. Hot-mix asphalt paving.
   2. Hot-mix asphalt patching.
   3. Hot-mix asphalt overlays.
   4. Asphalt surface treatments:
      a. Fog seals.
      b. Slurries.
   5. Pavement-marking paint.

B. Related Sections include the following:
   1. Section 31 20 00 "Earthwork" for aggregate subbase and base courses and aggregate pavement shoulders.
   2. Section 32 13 13 “Concrete Paving” for pavement marking on portland cement concrete pavement and herbicide treatment under portland cement concrete paving.
   3. Section 32 17 23 "Painted Pavement Marking" for pavement marking requirements.

1.3 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the standard specifications of the state or of authorities having jurisdiction.
   1. Reference Specification: Perform all work in accordance with applicable provisions of "Standard Specifications for Public Works Construction", 2012 Edition. Unless otherwise noted, mention herein of section numbers refers to sections of the Reference Specification. Where Reference Specification refers to "Agency", substitute the word "Owner". Where Reference Specification refers to "Engineer", substitute the word "Architect". Where Reference Specification is in conflict with these Specifications, these Specifications shall govern.
   2. Measurement and payment provisions and safety program submittals included in Reference Specifications do not apply to this Section.

1.4 SUBMITTALS

A. Product Data: For each product specified. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Job-Mix Designs: For each job mix proposed for the Work.

D. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate dedicated handicapped spaces with international graphics symbol.

E. Samples: 12 by 12 inches (300 by 300 mm) minimum, of paving fabric.

F. Qualification Data: 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.

G. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.

H. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.
   1. Firm shall be a registered and approved paving mix manufacturer with authorities having jurisdiction or with the DOT of the state in which Project is located.

C. Testing Agency Qualifications: Demonstrate to Architect's satisfaction, based on Architect's evaluation of criteria conforming to ASTM D 3666, that the independent testing agency has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

D. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work on public property.

E. Asphalt-Paving Publication: Comply with AI's "The Asphalt Handbook," except where more stringent requirements are indicated.

F. Preinstallation Conference: Review methods and procedures related to asphalt paving including, but not limited to, the following:
   1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
   2. Review condition of substrate and preparatory work performed by other trades.
   3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

4. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute the Work without delays.
5. Review inspection and testing requirements, governing regulations, and proposed installation procedures.
6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location and within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:
1. Prime and Tack Coats: Minimum surface temperature of 60 deg F (15.5 deg C).
2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F (4 deg C) and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.5 deg C) at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4 deg C) for oil-based materials, 50 deg F (10 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: Sound; angular crushed stone; crushed gravel; or properly cured, crushed blast-furnace slag; complying with ASTM D 692.

C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone; gravel, properly cured blast-furnace slag, or combinations thereof; complying with ASTM D 1073.
1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D 242.

2.2 ASPHALT PAVEMENT MATERIALS

A. Asphalt Pavement Leveling Course: Conform to Viscosity Grade B-PG 64-10 in section 203-1.2 and section 203-6 of the Reference Specification.

B. Asphalt Pavement Wearing (Surface) Course: Conform to Viscosity Grade III C2-PG 64-10, C3-PG 64-10 in section 203-1.2 and section 203-6 and section 400-4 to be used with Class III asphalt of the Reference Specification.

C. Prime Coat: Grade SC-70 liquid asphalt conforming to section 203-2 of the Reference Specification.

D Tack Coat: Emulsified asphalt grade SS-1h conforming to section 203-3 of the Reference Specification.

E. Asphalt Paint: Conform to ASTM D41 or D43 per section 203-8 of the Reference Specification.

F. Slurry Seal: Emulsified asphalt grade [SS-1h] [CSS-1h] and aggregate conforming to section 203.5 of the Reference Specification.

G. Asphalt Cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.

H. Asphalt Cement: ASTM D 3381 for viscosity-graded material.

I. Undersealing Asphalt: ASTM D 3141, pumping consistency.

J. Prime Coat: ASTM D 2027; medium-curing cutback asphalt; MC-30, MC-70, or MC-250.

K. Prime Coat: Asphalt emulsion prime conforming to state DOT requirements.

L. Prime Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

M. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

N. Fog Seal: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

O. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wettable powder form.

B. Sand: ASTM D 1073, Grade Nos. 2 or 3.

C. Paving Geotextile: Nonwoven polypropylene, specifically designed for paving applications, resistant to chemical attack, rot, and mildew.

D. Pavement-Marking Paint: Alkyd-resin type, ready-mixed, complying with FS TT-P-115, Type I, or AASHTO M-248, Type N.

E. Pavement-Marking Paint: Latex, water-base emulsion, ready-mixed, complying with FS TT-P-1952.
1. Color: As indicated.
2. Color: White (for parking stalls, other than handicapped).
3. Color: Yellow (for parking stalls, other than handicapped).
4. Color: Blue (for pavement markings identifying handicap parking)
5. Color: Red (for "No Parking" areas as shown)

F. Glass Beads: AASHTO M-247.

2.4 MIXES

A. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI's "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: As indicated.
3. Surface Course: As indicated.

B. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI's "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."
1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Provide mixes complying with the composition, grading, and tolerance requirements of ASTM D 3515 for the following nominal, maximum aggregate sizes:
a. Base Course: 1 inch (25 mm).
b. Surface Course: 1/2 inch (13 mm).

C. Emulsified-Asphalt Slurry: ASTM D 3910, consisting of emulsified asphalt, fine aggregates, and mineral fillers and as follows:
1. Composition: Type 1.
2. Composition: Type 2.
3. Composition: Type 3.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Subgrade, Subbase, and Base:
   1. Proof-roll prepared subgrade and base using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify Architect in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.2 COLD MILLING

A. Clean existing paving surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement, including hot-mix asphalt and, as necessary, unbound-aggregate base course, by cold milling to grades and cross sections indicated.
   1. Repair or replace curbs, manholes, and other construction damaged during cold milling.

B. Cold mill existing asphalt concrete pavement in accordance with section 302-5.2 of the Reference Specification.

3.3 PATCHING AND REPAIRS

A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.
   1. Tack coat faces of excavation and allow to cure before paving.
   2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
   3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
   1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
   2. Remove disintegrated or badly broken pavement. Prepare and patch with hot-mix asphalt.

C. Leveling Course: Install and compact leveling course consisting of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.
   1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.

D. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of 1/4 inch (6 mm). Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.

E. Asphalt paint: Apply uniformly to existing surfaces of previously constructed asphalt or Portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix

asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m) of surface.

1. Allow asphalt paint to cure undisturbed before paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
   1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
   1. Mix herbicide with prime coat when formulated by manufacturer for that purpose.

C. Prime Coat: Apply uniformly over surface of compacted-aggregate base at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 72 hours minimum.
   1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use just enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
   2. Protect primed substrate from damage until ready to receive paving.

D. Prime Coat: Comply with section 302-5.3 of the Reference Specification. Apply primer at a rate of between 0.20 and 0.25 gallons per square yard to top surface of base course prior to asphalt placement.

E. Tack Coat: If a leveling course has been used for construction traffic, apply tack coat to all leveling course surfaces in accordance with section 302-5.4 of the Reference Specification at a rate of 0.10 gallons per square yard.

F. Asphalt Paint: Apply uniformly to existing surfaces of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m) of surface.
   1. Allow asphalt paint to cure undisturbed before paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.
   1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.

2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F (121 deg C).
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide, except where infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

D. The asphalt pavement shall be completed in phases; the leveling course during construction for temporary construction traffic and storage of materials and; the wearing (surface) course just prior to turnover to Owner; unless the entire paving operation is completed just prior to turnover to the Owner such that no construction traffic or storage of materials shall be allowed on the finished pavement surface after its completion. Contractor shall schedule final surface course paving operations so that the required waiting period specified in the Division 2 Section "Pavement Marking" will allow project completion within the specified time.

E. Construct asphalt pavement in accordance with section 302-5 of the Reference Specification and as shown on the Drawings.

F. Two Layer Method: The leveling course shall be installed to elevations which will allow the future placement of a wearing (surface) course no thinner than 1-1/2 inches. Prior to placing the wearing (surface) course, repair all areas damaged during construction use , thoroughly clean the leveling course of all loose material and place a tack coat pursuant to paragraph 3.4 D. herein.

3.6 JOINTS

A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat.
2. Offset longitudinal joints in successive courses a minimum of 6 inches (150 mm).
3. Offset transverse joints in successive courses a minimum of 24 inches (600 mm).
4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's "The Asphalt Handbook."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to at least 95 percent of the Hveem density (ASTM D 2726-05a).

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt, with a thickness one inch greater than the existing, and to match existing finish surface grades such that no local ponding of water will result. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Leveling Course: Plus or minus 1/2 inch (13 mm).
   2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
   1. Leveling Course: 1/4 inch (6 mm).
   2. Surface Course: 1/8 inch (3 mm).
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

3.9 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.70 L/sq. m) to existing asphalt pavement and allow to cure. Lightly dust areas receiving excess fog seal with a fine sand.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
   1. Roll slurry seal to smooth ridges and provide a uniform, smooth surface.

C. Slurry seals: Apply in accordance with section 302-4 of the Reference Specification.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to cure for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
   1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

E. Comply with paint manufacturer's maximum drying time requirements to prevent undue softening of bitumen and pick-up, displacement, or discoloration of pavement marking by vehicular traffic.

F. Paint pavement, curbs and other surfaces, as shown on the Drawings. Painting shall be straight, uniform, exact and sharp without blobs at the start and finish. Edges shall be even, accurate, symmetrical and free of fuzziness.

G. Apply markings for disabled access symbols in accordance with State of California Building Code, Part 2, Title 24, CCR.

H. Where work consists of modifications of, or additions to existing parking striping, match existing color and width of lines as closely as possible.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.
   1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. Perform flood tests on asphalt paved areas to determine if surface grades allow proper runoff of surface water and if drainage devices function properly. Such tests shall be conducted in the presence of the Architect and the Owner. Promptly correct paving work found to be defective due to ponding of water or improper drainage.

F. In-Place Density tests will be performed using nuclear gauge (ASTM D 2950-05) to verify at least 95 percent relative compaction of the Hveem density has been achieved. Representative samples of the AC will be collected and tested in the laboratory for Hveem density (ASTM D 2726-05a), theoretical maximum density (ASTM D 2041-03a), stability (ASTM D 1560-05), gradation (ASTM C 136-05), and asphalt content (ASTM D 6307-05).

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

SECTION 321313 - CONCRETE PAVING

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 exterior Portland cement concrete paving for the following:
   1. Curbs and gutters.
   2. Walkways.
   3. Driveways
   3. Concrete pavement.
   4. Concrete wheel stops

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Section 31 20 00: Earthwork for subgrade preparation, grading and base course.
   2. Section 03 30 00: Cast-in-Place Concrete for general building applications of concrete.
   3. Section 32 13 73: Paving Joint Sealants for joint fillers and sealants within concrete paving and at joints with adjacent construction.

1.3 SYSTEM DESCRIPTION

A. Provide concrete pavement according to the materials, workmanship, and other applicable requirements of the following standard specifications:
   1. Reference Specification: Perform all work in accordance with applicable provisions of "Standard Specifications for Public Works Construction", 2012. Unless otherwise noted, mention herein of section numbers refers to sections of the Reference Specification. Where Reference Specification refers to "Agency", substitute the word "Owner". Where Reference Specification refers to "Engineer", substitute the word "Architect". Where Reference Specification is in conflict with these Specifications, these Specifications shall govern.
   2. Measurement and payment provisions and safety program submittals included in Reference Specifications do not apply to this Section.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Design mixes for each class of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Description of Methods and Sequence of Placement. For each type of specially-finished concrete provide description of methods and sequence of placement.

D. Submit manufacturer's product data for the following:
   1. Form release agent.
   2. Concrete coloring additive.
   3. Prefabricated control joint.
   4. Preformed joint filler.
   5. Sealants.
   6. Slip plane joint.
   7. Concrete mix design.

1.5 QUALITY ASSURANCE

A. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.
   1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
   2. ACI 318, "Building Code Requirements for Reinforced Concrete."
   3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
   4. Standard specifications for PWC (Green Book) latest edition, section 201-1.

B. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Paving work, base course etc., shall be done only after excavation and construction work, which may damage them, have been completed. Damage caused during construction shall be repaired before acceptance.

D. Existing paving area shall, if damaged or removed during the course of this project, be repaired or replaced under this section of the specification. Workmanship and materials for such repair and replacement, except as otherwise noted, shall match as closely as possible those employed in existing work.

E. Pavement, base, or subbase shall not be placed on a muddy subgrade.

F. Provide control joints as required to construct 100 sq. ft. maximum panel sizes. Score lines to be tooled. Reference Landscape drawings for locations. Note on shop drawings.

G. Concrete Testing Service: Engage a qualified independent testing agency to perform materials evaluation tests and to design concrete mixes.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.7 TESTING AND INSPECTION

A. The owner reserves the right to inspect and test paving and associated work.

PART 2 PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves of a 100-foot or less radius.

B. Form Release Agent: Provide commercial formulation form-release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
      a. Debond Form Coating, L & M Construction Chemicals.
      b. Crete-Lease 880 VOC, Cresset Chemical Company.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars and Tie Bars: ASTM A 615, Grade 40 for #3 bars and Grade 60 for bars larger than #3, deformed.

B. Plain, Cold-Drawn Steel Wire: ASTM A 82.

C. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.

D. Dowel Sleeves: Speed Dowel, Aztec Concrete Accessories, Inc.

E. Hook Bolts: ASTM A 307, Grade A bolts, internally and externally threaded. Design hook bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

F. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.
   1. Use supports with sand plates or horizontal runners where base material will not support chair legs.

G. Welded wire fabric reinforcement shall conform to the applicable requirements of ASTM A185. Fabric reinforcement shall be furnished in flat sheets. Fabric reinforcement in rolls will not be permitted.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type II
   1. Use one brand of cement throughout Project. Coordinate with Division 3 Section "Cast-In-Place Concrete."

B. Normal-Weight Aggregates: ASTM C 33, Class 4M non-reactive, and as follows. Provide aggregates from a single source.
   1. Maximum Aggregate Size: 1-inch.
   2. Do not use fine or coarse aggregates that contain substances that cause spalling.
   3. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Architect.

C. Water: Potable.

D. Admixtures: Comply with requirements specified in Division 3 Section "Cast-In-Place Concrete."
   1. Do not use admixtures containing calcium chloride or chloride ions.

2.4 COLOR ADMIXTURE

A. Color admixture shall be suitable for flatwork concrete and shall meet or exceed the requirements set by Portland Cement Association (PCA) and ATSM C 494.

B. Color admixture shall be of a type and quality which will not adversely affect workability, setting, or strength of concrete. Color pigments shall consist of chemically inert, non-fading, alkali-fast mineral oxides, finely ground and specially prepared for the use in both cement and mortar. Admixture shall not contain calcium chloride.

C. Color admixture shall be Chromix admixture, manufactured by L.M. Scofield Company, Los Angles, CA 90040.

D. Mix design shall conform to manufacturer's recommendations, and directions of the Architect to achieve proposed color. Strictly monitor additive / cement ratio throughout job to ensure uniform color.

2.5 CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
   1. Waterproof paper.
   2. Polyethylene film.
   3. White burlap-polyethylene sheet.

C. Liquid Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B. Moisture loss not more than 0.55 kg./sq. meter in 72 hours when applied at a rate of 200 sq. ft./gal.
   1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. L & M Cure R, L & M Construction Chemicals, Inc.
      b. 1100-Clear, W.R. Meadows, Inc.
   3. Do not use sodium silicate type curing agents.

D. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Eucobar; Euclid Chemical Co.
      b. E-Con; L&M Construction Chemicals, Inc.
      c. Confilm; Master Builders, Inc.

2.6 RELATED MATERIALS

A. Bonding Agent: Acrylic or styrene butadiene, complying with ASTM C 1059, Type 2.

B. Epoxy Adhesive: ASTM C 881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.

C. Products: Subject to compliance with requirements, provide one of the following:
   1. Bonding Agent:
      a. SBR Latex; Euclid Chemical Co.
      b. Daraweld C; W.R. Grace & Co.
      c. Everbond; L&M Construction Chemicals, Inc.
      d. Acryl-Set; Master Builders Inc.
   2. Epoxy Adhesive:
      a. Burke Epoxy M.V., The Burke Co.
      b. Concresive Standard Liquid; Master Builders, Inc.
      c. Rezi-Weld 1000; W.R. Meadows, Inc.

D. Concrete Sealer: Water-based, deep penetrating, non-staining, non-darkening silane micro emulsion.
   1. Positive chloride-ion screening, prevents water intrusion, minimizes rebar corrosion and potential concrete spalling, and protects against damaging effects of alkalis and other contaminants.
   2. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.
   3. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following::
      a. Pentane WB, L & M Construction Chemicals, Inc. This product is intended to establish the characteristics and level of quality intended for this Project.

E. Expansion and Isolation Joint Fillers: ASTM D 1751, cellulosic fiber.

2.7 CONCRETE MIX

A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use a qualified independent testing agency for preparing and reporting proposed mix designs.
   1. Do not use the Owner's field quality-control testing agency as the independent testing agency.

B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:

1. Compressive Strength (28-Day): 2500 psi for concrete for sidewalks; 3250psi for concrete for traffic areas, curbs and gutters.
2. The minimum cement content shall be 5-1/4 sacks per cubic yard.
3. The maximum concrete slump shall be 3 inches, plus or minus 1/2 inch, for all walks; and 4 inches, plus or minus 1 inch for all other Portland cement concrete paving.
4. Water/Cement Ratios:
   a. 0.5 maximum for concrete for pavement and site flatwork.
   b. 0.45 maximum for all other concrete.

C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, project conditions, weather, test results, or other circumstances warrant.

D. Admixtures: Comply with requirements specified in Division 3 Section "Cast-In-Place Concrete".

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.
1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2.9 GROUT

A. Grout shall be mixed in the proportions of one part Portland cement to two parts sand, by volume. Only sufficient water shall be used to enable grout to barely hold its shape when squeezed into a ball in the hand. Sand for grout shall be "Fine Aggregate", conforming to ASTM C 33.

B. Non-shrink grout shall be pre-mixed non-shrinking, high strength grout. Compressive strength in 28 days shall be 5,000 psi minimum, but in no case less than the specified strength of the adjacent concrete. Manufacturer shall provide evidence that the material meets the requirements of the COE CRD-C 621 (558). Grout permanently exposed to view shall be non-oxidizing; metallic grout may be used in other locations.
1. Non-shrink grout shall be one of the following or approved equal:

Manufacturer	Product
Gifford-Hill Co.	Supreme
Master Builders Co.	Embeco
U.S. Grout Corporation	Five Star Grout

2.10 SANDBLASTING MATERIAL

A. Material for sandblasting shall be 16/20 mesh sand.

2.11 HERBICIDE TREATMENT

A. Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid, or wettable powder form.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
      a. Ciba-Geigy Corp.
      b. Dow Chemical U.S.A.
      c. E.I. Du Pont de Nemours & Co., Inc.
      d. FMC Corp.
      e. Thompson-Hayward Chemical Co.
      f. U.S. Borax and Chemical Corp.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Areas to be paved shall be compacted and brought to subgrade elevation per soils report before work of this section is performed. Final fine grading, filling, and compaction of areas to receive paving, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be done under this Section.

B. Existing subgrade material which will not readily compact as required shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material conforming to this Section.

C. Subgrade of areas to be paved shall be re-compacted per soils report.

D. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, base, or pavement, subsequent backfill and compaction shall be performed per soils report.

E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 in. deep in subgrade, shall be graded out, reshaped as required, and re-compacted before placing pavement.

F. Materials shall not be stored or stockpiled on subgrade.

G. Disposal of debris and other material excavated under this section, and material unsuitable for or in excess of requirements for completing work of this section shall be disposed of off-site.

H. Prepared subgrade will be inspected by Soils Engineer. Subgrade shall be approved before installation of gravel base course. Disturbance to subgrade caused by inspection procedures shall be repaired under this section of the specification.

I. Proof-roll subgrade or base surface prepared by others to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

J. Herbicide Treatment: Apply chemical weed control agent in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry subgrade prior to installation of base course.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

B. Check completed formwork and screeds for grade and alignment to following tolerances:
1. Top of Forms: Not more than 1/8 inch in 10 feet.
2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.

C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, or other bond-reducing materials. Where there is delay in placing concrete after reinforcement is in place, bars shall be re inspected and cleaned when necessary.

C. Any bar showing cracks after bending shall be discarded.

D. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

F. After forms have been coated with form release agent, but before concrete is placed, reinforcing steel anchors shall be securely wired in the exact position called for, and shall be maintained in that position until concrete is placed and compacted. Chair bars and supports shall be provided in a number and arrangement satisfactory to the Architect.

3.4 JOINTS

A. General: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.
1. When joining existing paving, place transverse joints to align with previously placed joints, unless indicated otherwise.

2. Make joints full depth required and from edge to edge of paving.

B. Contraction Joints: Provide weakened-plane contraction joints, sectioning concrete into areas as shown on Drawings. Construct contraction joints for a depth equal to at least 1/4 of the concrete thickness, as follows:
   1. Tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.
   2. Inserts: Form contraction joints by inserting pre-molded plastic, hardboard, or fiberboard strips into fresh concrete until top surface of strip is flush with paving surface. Radius each joint edge with a jointer tool. Carefully remove strips or caps of two-piece assemblies after concrete has hardened. Clean groove of loose debris.

C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than 1/2 hour, unless paving terminates at isolation joints.
   1. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
   2. Provide tie bars at sides of paving strips where indicated.
   3. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

D. Isolation Joints: Form isolation joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
   1. Locate expansion joints at intervals of 50 feet, unless indicated otherwise.
   2. Extend joint fillers full width and depth of joint, not less than 1/2 inch or more than 1 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.
   3. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
   4. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

E. Installation of joint fillers and sealants is specified in Section "Joint Sealants."

F. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one half of dowel length to prevent concrete bonding to one side of joint.

G. Where spacing is not shown, locate expansion joints at 10-foot maximum spacing.

H. Where plastic "zip strips" are used to construct concrete joints, cut and remove, as a minimum, the top 1/4 inch of these strips after concrete has cured, and coordinate installation of joint filler, if shown on the Drawings, as specified in Section " Joint Sealants".

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Moisten subgrade or base to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

C. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.

D. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

E. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

F. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.
   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.

G. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.

H. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.

I. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

J. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.
   1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 CONCRETE FINISHING

A. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes within a tolerance of 1/4 inch in 10 feet as determined by a 10-foot-long straightedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots. Refloat surface immediately to a uniform granular texture.
   1. Burlap Finish: Drag a seamless strip of damp burlap across concrete, perpendicular to line of traffic, to provide a uniform gritty texture finish.
   2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across concrete surface perpendicular to line of traffic to provide a uniform fine line texture finish.
   3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating surface 1/16 inch to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
   4. Do not use troweling machines within 12 inches of electrical junction and outlet boxes which are set to finish flush with concrete slabs. Float and trowel such areas by hand with wood floats and steel trowels, taking care to see that concrete is finished flush with box cover and matches adjacent surfaces.

B. Slip-Resistant Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on pavement surface in accordance with manufacture's written instructions
   1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
   2. After Curing, lightly work surface with a steel wire brush or abrasive stone and water to expose non-slip aggregate

C. Finishing formed surfaces:
   1. Curb forms shall leave a smooth face.
   2. Remove all fins.

D. Provide steel trowel finish on tops of curbs and flow lines of curbs, gutters and integral curb and gutters.

E. Final Tooling: Tool edges of paving, gutters, curbs, and joints formed in fresh concrete with a jointing tool to the following radius. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.
   1. Radius: 1/4 inch.
   2. Radius: 3/8 inch.

F. Finish surfaces to produce a uniform appearance throughout area involved and throughout adjacent areas with the same treatment.

G. Sandblast finish shall be consistent finish throughout and match approved mock-up.

H. Where concrete finishing occurs adjacent to finished metal or other surfaces, particularly where serrated or indented surfaces occur, remove all traces of cement film before allowing to harden.

I. Apply integral wood float and broom finish to the all concrete pavements and walkways, unless otherwise shown on the Drawings.
   1. After screeding and compacting, finish with a wood float using a circular motion to produce a uniform texture and finish throughout.
   2. For vehicular traffic areas, the finish shall be coarse enough to provide a non-slip surface with a minimum static friction coefficient of 0.6.
   3. For pedestrian traffic areas, finish shall be a non-slip surface with a minimum static coefficient of friction of 0.6.
      a. For ramps, the static coefficient of friction shall be a minimum of 0.8. Ramps are defined as any sloping path of travel with a slope in the direction of travel of 5.0%, or greater.
   4. Tests for coefficient of friction shall be either ASTM C-1028 (field test) or ASTM D-2047 (laboratory test).

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.

B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
   1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

E. Spray-apply concrete sealer to all concrete pavement. Comply with sealer manufacturer's application instructions.

3.8 CURING COLORED CONCRETE

A. Colored concrete shall not, under any circumstances, be cured using water fog misting or ponding, burlap, plastic sheeting, or other wet covering.

B. Curing material and method shall be in strict conformance with manufacturer's guidelines and recommendations.

C. Only if additional protection is absolutely required, the surface should remain uncovered for at least 4 days, after which time new and unwrinkled non-staining reinforced waterproof kraft curing paper may be used.

3.9 FIELD QUALITY CONTROL TESTING

A. The Owner will employ a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include the following:
   1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
      a. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
      b. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test but no less than one test for each day's pour of each type of air-entrained concrete.
      c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
      d. Compression Test Specimens: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless directed otherwise. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
      e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. Test one specimen at 7 days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
   2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
   3. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
   4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
   5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and

no individual strength test result falls below specified compressive strength by more than 500 psi.

B. Test results will be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in paving, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.

C. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

D. Additional Tests: The testing agency will make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

E. Manufacturer's Field Service: When placing integral colored concrete, arrange for the services of a qualified technical representative of the color pigment manufacturer, equipped with wet-batch color control test devices to ensure concrete of uniform color and matching approved mock-up.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section. Concrete which is not true to line and plane, which is not thoroughly troweled and properly surfaced as required, which varies in excess of 1/4-inch along a 10-foot straight edge, which is scuffed or has a rough top surface, except where required, or which does not connect properly to adjoining work, does not slope as required for drainage or is not properly cured, will be deemed defective.
   1. General: Patch defective areas immediately following form removal. Remove defective concrete to a width and depth necessary for proper patching, but in no case less than 1 inch deep. Make the walls of the cut area perpendicular to the surface and do not feather out the edge. Dampen the patch area and the adjacent area 6 inches around the patch area.
   2. Exposed concrete: Prepare a patching mortar of one part Portland cement, adjusted to match the color of the surrounding concrete, and 2-1/2 parts sand with the least water required to produce a workable mass. Re-work this mortar until it is the stiffest consistency that will permit placing. Brush the patch area with a bond of neat cement and water paste and apply patching mortar when the water sheen is off the bond. Strike off the mortar slightly higher than the surrounding surface, let set for 1 hour and finish flush with the surrounding surface.

B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

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:
   1. Expansion and contraction joints within cement concrete pavement.
   2. Joints between cement concrete and asphalt pavement.

B. Related Sections include the following:
   1. Section 01 10 10 Sustainable Design Requirements
   2. Division 32 Section "Decorative Concrete Paving" for constructing joints in concrete pavement.
   3. Division 33 Section “Landscape Architectural Concrete” for constructing joints at concrete walls and other appurtenances.

1.3 SUBMITTALS

A. Comply with Section 13 33 00 Submittal Procedures and Section 01 10 10 - Sustainable Design Requirements.

B. Product Data: For each joint-sealant product indicated.

C. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

E. Qualification Data: For Installer.

F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

H. Provide product cut sheet or Material Safety Data Sheet (MSDS) for each material used highlighting VOC limits (Volatile Organic Compound Emissions). All materials should comply with SDR Low-Emitting material requirement per SCAQMD (South Coast Air Quality Management District) Rules 1113 and 1168 scheduled for 2007

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use [ASTM C 1087] to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit not fewer than [eight] pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the commencement of the Work.
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.

2. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).
3. When joint substrates are wet or covered with frost.
4. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
5. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience

B. Colors of Exposed Joint Sealants: [As selected by Architect from manufacturer's full range].

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete: Single-component, pourable, coal-tar-modified, urethane formulation complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.

B. One part moisture curing polyurethane sealant designed for caulking applications of exterior horizontal joints. Self-leveling and compatible for uses with the expansion material.
1. Products:
   a. Sonneborn, Div. of ChemRex, Inc.; Sonomeric 1.
   b. Polytite
   c. Tremco

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Weeding: Before finish grading, weeds and grasses shall be dug out by the root or sprayed with an herbicide and disposed of off-site. This procedure is outlined under the Landscape Planting Section.

B. Debris: Remove stones and debris 1 inch in diameter and greater and clumps of earth that do not break up. Dispose of off-site.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of backer materials.
   2. Do not stretch, twist, puncture, or tear backer materials.
   3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed
   1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work

END OF SECTION

SECTION 321723 - PAINTED PAVING

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 surface preparation and field application of pavement marking on hot-mix asphalt paving and portland cement concrete paving.

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 product specified. Include technical data and tested physical and performance properties. Provide recommended dry film and wet film thickness for each paint product type.

C. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate dedicated handicapped spaces with international graphics symbol.

D. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.

E. Qualification data 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.

F. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of pavement marking material from one source and by a single manufacturer.

B. Installer Qualifications: Engage an experienced installer who has completed pavement marking similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a covered, clean, dry, protected location and within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4 deg C) for oil-based materials, 50 deg F (10 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products specifically formulated for pavement marking by one of the following:
   1. Dunn-Edwards Paints (Dunn-Edwards).
   2. Sinclair Paint (Sinclair).
   3. Sherwin Williams.

2.2 PAVEMENT MARKING MATERIALS

A. Pavement-Marking Paint: Alkyd-resin type, ready-mixed, complying with FS TT-P-115, Type I, or AASHTO M-248, Type N, and suitable for use on both hot-mix asphalt and portland cement concrete paving.

B. Pavement-Marking Paint: Latex, water-base emulsion, ready-mixed, complying with FS TT-P-1952, and suitable for use on both hot-mix asphalt and portland cement concrete paving. Provide material having a volatile organic compound (VOC) content of 250 g/L, or less.

C. Pavement-Marking Paint: Epoxy fortified vinyl/acrylic or acrylic-emulsion water-based traffic paint suitable for use on both hot-mix asphalt and portland cement concrete paving. Provide material having a volatile organic compound (VOC) content of 250 g/L, or less.
   1. Colors:
      a. As indicated.
      b. Color: White (for all parking stalls other than handicapped parking, and for traffic and lane marking).
      c. Color: Yellow.
      d. Color: Red (for "No Parking" areas as shown).
      e. Color: Blue equal to Color No. 15090 per Federal Standard 595 B (for pavement markings identifying disabled parking spaces).
   2. Gloss: Flat.
   3. Products: Subject to compliance with requirements, provide one of the following:
      a. Dunn-Edwards: Vin-L-Stripe W 801 Series.
      b. Sinclair: Traffic Paint 160 (white), 161 (red), 162 (yellow), and 166 (blue).
      c. Sherman Williams: Setfast Latex Traffic Marking Paints and Setfast Acrylic Waterborne Traffic Marking Paint.
      d. Sherman Williams: Setfast Quick Dry Latex Traffic Paint.

D. Glass Beads: AASHTO M-247 or California State Specification 8010-71L-22.

E. Surface Cleaning Material: Cleaning agent or agents suitable for removing grease, oil, and other contaminants that will not damage asphalt or portland cement concrete paving and are acceptable to pavement marking paint manufacturer.

PART 3 EXECUTION

3.1 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to cure for a minimum of 30 days before starting pavement marking. Comply with recommendations of the pavement marking paint manufacturer for longer cure periods.

C. Sweep and clean surface to eliminate loose material and dust. Ensure all surfaces indicated to receive pavement marking are clean and free from grease, oil, concrete sealers and curing agents, and other contaminants that might interfere with paint adhesion.
1. Comply with manufacturer's instructions for use of special cleaning agents.
2. For removal of substances that would interfere with paint adhesion use methods recommended by the paint manufacturer if applicable, or methods that will completely remove the substance without damaging or discoloring the underlying pavement substrate.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates based on substrate type and cure conditions. Do not exceed manufacturer's recommended application rates.
1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

E. Comply with paint manufacturer's maximum drying time requirements before allowing traffic in order to prevent undue softening of bitumen and pick-up, displacement, or discoloration of pavement marking by vehicular traffic.

F. Paint pavement, curbs, and other surfaces as shown on the Drawings. Painting shall be straight, uniform, exact, and sharp without blobs at the start and finish. Edges shall be even, accurate, symmetrical, and free of fuzziness.
1. Edge Tolerance: 1/2 inch in 20 feet, maximum.

G. Apply markings for disabled access symbols in accordance with State of California Building Code, Part 2, Title 24, CCR. Painted lines and marking on pavement shall be 3" minimum wide. Parking spaces for the disabled shall be marked according to CBC Section 11B-502. Tactile warning lines shall be in conformance to CBC Section 11B-705.

H. Where work consists of modifications of, or additions to existing pavement marking, match existing color and line width.

3.2 ADJUSTING

A. Touch up pavement markings not complying with requirements of this Section by painting out the errors with permanently opaque paint of the same color as the substrate pavement.
   1. Block out and eliminate all traces of splashed, tracked, and spilled pavement marking paint from the background surfaces.
   2. Paint over deviations in marking edges exceeding allowable tolerance and apply new marking meeting specified requirements.

B. The Owner reserves the right to require sandblast removal of extensive defective pavement marking and application of new marking meeting specified requirements at no additional cost.

3.3 PROTECTION

A. Provide traffic cones, barricades, and other devices needed to protect the pavement marking until it is sufficiently dry to withstand traffic without damage.

END OF SECTION

SECTION 328000 – LANDSCAPE IRRIGATION

PART 1- GENERAL

1.01 SUMMARY

A. It is the intent of the specifications and drawings that the finished system is complete in every respect and shall be ready for operation satisfactory to the Owner.

B. The work shall include all materials, labor, services, transportation, and equipment necessary to perform the work as indicated on the drawings, in these specifications, and as necessary to complete the contract.

1.02 CONSTRUCTION DRAWINGS

A. Due to the scale of the drawings, it is not possible to indicate all offsets, fittings, sleeves, etc. which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc. as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such a manner as to avoid conflicts between irrigation systems, planting, and architectural features.

B. All work called for on the drawings by notes or details shall be furnished and installed whether or not specifically mentioned in the specifications. When an item is shown on the plans but not shown on the specifications or vice versa, it shall be deemed to be as shown on both. The AOR shall have final authority for clarification.

C. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences should be brought to the attention of the Architect as soon as detected. In the event this notification is not performed, the Contractor shall assume full responsibility for any revision necessary.

1.03 QUALITY ASSURANCE

A. Provide at least one English speaking person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation and who shall direct all work performed under this section.

B. Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturer of articles used in this contract furnish directions covering points not shown in the drawings and specifications.

C. All local, municipal, and state laws, rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.

D. All materials supplied for this project shall be new and free from any defects. All defective materials shall be replaced immediately at no cost to the Owner.

E. The Contractor shall secure the required licenses and permits including payments of charges and fees, give required notices to public authorities, verify permits secured or arrangements made by others affecting the work of this section.

1.04 SUBMITTALS

A. Submittals Materials List:
   1. After award of contract and before any irrigation system materials are ordered from suppliers or delivered to the job site, submit to the Architect a complete list of all irrigation system materials, or processes proposed to be furnished and installed as part of this contract.
   2. The submittals materials list shall include the following information:
      a. A title sheet with the job name, the Contractor's name, Contractor's address and telephone number, submittal date and submittal number.
      b. An index sheet showing the item number (i.e. 1,2,3, etc.); an item description (i.e. sprinkler head); the manufacturer's name (i.e. Rainbird); the item model number (i.e. 1404); and the page(s) in the submittal set that contain the catalog cuts.
      c. The catalog cuts shall be one or two pages copied from the most recent manufacturer's catalog that indicate the product submitted. Do not submit parts lists, exploded diagrams, price lists or other extra information
      d. The catalog cuts shall clearly indicate the manufacturer's name and the item model number. The item model number, all specified options and specified sizes shall be circled on the catalog cuts.
      e. Submittals for equipment indicated on the legend without manufacturer names, or 'as approved', shall contain the manufacturer, class or schedule, ASTM numbers and/or other certifications as indicated in these specifications.
   3. Submittal materials list format requirements:
      a. Submittals shall be provided as one complete package for the project. Multiple partial submittals will not be reviewed.
      b. Submittal package shall have all pages numbered in the lower right corner. Page numbers shall correspond with submittal index.

c. Re-submitted packages must be revised to include only the equipment being re-submitted. Equipment previously reviewed and accepted shall not be resubmitted in the materials list/index sheet or in the catalog cut sheet package.

A. Substitutions: If the Contractor wishes to substitute any equipment or materials for those equipment or materials listed on the irrigation drawings and specifications, he may do so by providing the following information to the Architect for approval.
   1. Provide a written statement indicating the reason for making the substitution.
   2. Provide catalog cut sheets, technical data, and performance information for each substitute item.
   3. Provide in writing the difference in installed price if the item is accepted.

B. The Owner will allow no substitutions without prior written acceptance.

C. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.

D. The Architect will not review the submittal package unless provided in the format described above.

1.05 EXISTING CONDITIONS

A. The Contractor shall verify and be familiar with the locations, size and detail of points of connection provided as the source of water, and electrical supply connection to the irrigation system.

B. Irrigation design is based on the available static water pressure. The contractor shall verify the static water on the project is adequate for the design prior to the start of construction. Should a discrepancy exist, notify the Owner prior to beginning construction.

C. Prior to cutting into the soil, the Contractor shall locate all cables, conduits, sewer septic tanks, and other utilities as are commonly encountered underground and he shall take proper precautions not to damage or disturb such improvements.

D. The Contractor shall protect all existing utilities and features to remain on and adjacent to the project site during construction. Contractor shall repair, at his own cost; all damage resulting from his operations or negligence.

E. The Contractor shall coordinate the installation of required sleeving as shown on the plans prior to paving operations.

F. The Contractor shall verify and be familiar with the existing irrigation systems in areas adjacent to and within the Project area of work.

G. The Contractor shall protect all existing irrigation systems, in areas adjacent to the

Project area of work, from damage due to his operations.

H. The Contractor shall notify the Owner if any existing system is temporarily shut off, capped or modified. Provide 48-hour notice prior to turning off or modifying any existing irrigation system.

I. The Contractor shall repair or replace all existing irrigation systems, in areas adjacent to the Project area of work, damaged by the construction of this project. Adjacent irrigation systems shall be made completely operational and provide complete coverage of the existing landscape areas. All repairs shall be complete to the satisfaction of the Owner.

J. The Contractor shall provide bore holes under any existing pavement or paving encountered for the required lateral, mainline and low voltage control wire sleeving. Bore holes under 2 inches in diameter and smaller shall be made with a BulletMole underground boring tool as manufactured by Dimension Tools, LLC (contact telephone number (888) 650-5554 or at www.bulletmole.com). Bore holes larger than 2 inches in diameter shall be made with an approved mechanical boring tool. No air jacking or hydraulic boring of any kind shall be allowed.

1.06 INSPECTIONS

A. The Contractor shall permit the Owner and Architect to visit and inspect at all times any part of the work and shall provide safe access for such visits.

B. Where the specifications require work to be tested by the Contractor, it shall not be covered over until accepted by the Owner and/or governing agencies. The Contractor shall be solely responsible for notifying the Owner and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing. Should any work be covered without testing or acceptance, it shall be, if so ordered, uncovered at the Contractor's expense.

C. Inspections will be required for the following at a minimum:
   1. Pre-construction meeting.
   2. System layout.
   3. Pressure test of irrigation mainline (Four hours at 125 PSI or 120% of static water pressure, whichever is greater.) Mainline pressure loss during test shall not exceed 2 PSI.
   4. Coverage test of irrigation system. Test shall be performed prior to any planting.
   5. Final inspection prior to start of maintenance period.
   6. Final acceptance prior to turnover.

D. Site observations and testing will not commence without the field record drawings as prepared by the Contractor. Record drawings must be complete and up to date for each site visit.

E. Work that fails testing and is not accepted will be retested. Hourly rates and expenses of the Architect and governing agencies for re-inspection or retesting will be paid by the Contractor at no additional expense to Owner.

1.07 STORAGE AND HANDLING

A. Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installation work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Owner and at no additional cost to the Owner.

B. Exercise care in handling, loading, unloading, and storing plastic pipe and fittings under cover until ready to install. Transport plastic pipe only on a vehicle with a bed long enough to allow the pipe to lay flat to avoid undue bending and concentrated external load.

1.08 CLEANUP AND DISPOSAL

A. Dispose of waste, trash, and debris in accordance with applicable laws and ordinances and as prescribed by authorities having jurisdiction. Bury no such waste material and debris on the site. Burning of trash and debris will not be permitted. The Contractor shall remove and dispose of rubbish and debris generated by his work and workmen at frequent intervals or when ordered to do so by the Owner.

B. At the time of completion the entire site will be cleared of tools, equipment, rubbish and debris which shall be disposed of off-site in a legal disposal area.

1.09 TURNOVER ITEMS

A. Record Drawings:
   1. Record accurately on one set of drawings all changes in the work constituting departures from the original contract drawings and the actual final installed locations of all required components as shown below.
   2. The record drawings shall be prepared to the satisfaction of the Owner. Prior to final inspection of work, submit record drawings to the Architect.
   3. All record drawings shall be prepared using AutoCad 2014 drafting software and the original irrigation drawings as a base. Base files are from the AOR, through CM. No manual drafted record drawings shall be acceptable. The Contractor may obtain digital base files from the Owner.
   4. Prior to final inspection of work, submit record drawings plotted onto bond sheets for review by the Owner. The Contractor shall also provide record drawing information on a digital AutoCad Release 2014 drawing file. All digital files shall be provided on a compact disc (CD) clearly marked with the project name, file descriptions and date.
      a. Record drawing information and dimensions shall be collected on a day-to-day basis during the installation of the pressure mainline to fully indicate all routing locations and pipe depths. Locations for all other

irrigation equipment shall be collected prior to the final inspection of the work.

b. Two dimensions from two permanent points of reference such as buildings, sidewalks, curbs, streetlights, hydrants, etc. shall be shown for each piece of irrigation equipment shown below. Where multiple components are installed with no reasonable reference point between the components, dimensioning may be made to the irrigation equipment. All irrigation symbols shall be clearly shown matching the irrigation legend for the drawings. All lettering on the record drawings shall be minimum 1/8 inch in size.

5. Show locations and depths of the following items:
   a. Point of connection (including water POC, backflow devices, master control valves, flow sensors, etc.)
   b. Routing of sprinkler pressure main lines (dimensions shown at a maximum of 100 feet along routing)
   c. Isolation valves
   d. Automatic remote control valves (indicate station number and size)
   e. Quick coupling valves
   f. Drip air relief and flush valves
   g. Routing of control wires where separate from irrigation mainline
   h. Existing Rain Master Irrigation controller (indicate controller number and station count)
   i. Related equipment (as may be directed)

B. Controller Charts:
   1. Provide one controller chart for each automatic controller. Chart shall show the area covered by the particular controller. The areas covered by the individual control valves shall be indicated using colored highlighter pens. A minimum of fifteen individual colors shall be used for the controller chart unless less than fifteen control valves are indicated.
   2. Architect must approve record drawings before controller charts are prepared.
   3. The chart is to be a reduced copy of the actual "record" drawing to 11"x17" size. In the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a readable size.
   4. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 20 mils in thickness.

C. Operation and Maintenance Manuals:
   1. Two individually bound copies of operation and maintenance manuals shall be delivered to the Owner at least 10 calendar days prior to final inspection. The manuals shall describe the material installed and the proper operation of the system.
   2. Each complete, bound manual shall include the following information:
      a. Index sheet stating Contractor's address and telephone number, duration of guarantee period, list of equipment including names and addresses of local manufacturer representative.

b. Operating and maintenance instructions for all equipment.
c. Spare parts lists and related manufacturer information for all equipment.

D. Equipment:
1. Supply as a part of this contract the following items:
a. Two (2) wrenches for disassembly and adjustment of each type of sprinkler head used in the irrigation system.
b. Three (3) 30-inch sprinkler keys for manual operation of control valves.
c. Two (2) quick coupler keys with a 1" bronze hose bib, bent nose type with hand wheel and two coupler lid keys.
d. One valve box cover key or wrench.
e. Six extra sprinkler heads of each size and type.
f. For specified gate valves if required: One (1) 5-foot long valve handle, to fit 2-inch square AWWA operating nut, for use with the specified gate valves.
2. The above equipment shall be turned over to the Owner at the final inspection.

1.10 COMPLETION

A. At the time of the pre-maintenance period inspection, the Architect and governing agencies will inspect the work, and if not accepted, will prepare a list of items to be completed by the Contractor. Punch list to be checked off by Contractor and submitted to Owner prior to any follow-up meeting. This checked off list to indicate that all punch list items have been completed. At the time of the post-maintenance period or final inspection the work will be re-inspected and final acceptance will be in writing by the Owner.

B. The Owner shall have final authority on all portions of the work.

C. After the system has been completed, the Contractor shall instruct the Owner in the operation and maintenance of the irrigation system and shall furnish a complete set of operating and maintenance instructions.

D. Any settling of trenches which may occur during the one-year period following acceptance shall be repaired to the Owner's satisfaction by the Contractor without any additional expense to the Owner. Repairs shall include the complete restoration of all damage to planting, paving or other improvements of any kind as a result of the work.

1.11 GUARANTEE

A. The entire sprinkler system, including all work done under this contract, shall be unconditionally guaranteed against all defects and fault of material and workmanship, including settling of backfilled areas below grade, for a period of one (1) year following the filing of the Notice of Completion.

B. Should any problem with the irrigation system be discovered within the guarantee

period, it shall be corrected by the Contractor at no additional expense to the Owner within ten (10) calendar days of receipt of written notice from the Owner. When the nature of the repairs as determined by the Owner constitute an emergency (i.e. broken pressure line) the Owner may proceed to make repairs at the Contractor's expense. Any and all damages to existing improvement resulting either from faulty materials or workmanship, or from the necessary repairs to correct same, shall be repaired to the satisfaction of the Owner by the Contractor, all at no additional cost to the Owner.

C. Guarantee shall be submitted on the Contractor's own letterhead as follows:

GUARANTEE FOR SPRINKLER IRRIGATION SYSTEM
We hereby guarantee that the sprinkler irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the drawings and specifications, ordinary wear and tear and unusual abuse, or neglect excepted. We agree to repair or replace any defective material during the period of one year from date of filing of the Notice of Completion and also to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within 10 calendar days following written notification by the Owner. In the event of our failure to make such repairs or replacements within the time specified after receipt of written notice from Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefore upon demand.

PROJECT NAME:

PROJECT LOCATION:

CONTRACTOR NAME:

ADDRESS:

TELEPHONE:

SIGNED:

DATE:

PART 2 MATERIALS

2.01 SUMMARY

Use only new materials of the manufacturer, size and type shown on the drawings and specifications. Materials or equipment installed or furnished that do not meet the Owner's standards shall be removed from the site at no expense to the Owner.

2.02 PIPE

A. Pressure supply lines 2 inches in diameter and smaller downstream of the backflow unit shall be schedule 80 solvent weld PVC conforming to ASTM D1785.

B. Non-pressure lines ¾ inch in diameter and larger downstream of the remote control valve shall be SCH 40 solvent weld PVC conforming to ASTM D1785.

2.03 METAL PIPE AND FITTINGS

A. Brass pipe shall be 85 percent red brass, ANSI, IPS Standard 125 pounds, Schedule 40 screwed pipe.

B. Fittings shall be medium brass, screwed 125-pound class.

C. Copper pipe and fittings shall be Type "K" sweat soldered, or brazed as indicated on the drawings.

2.04 PLASTIC PIPE AND FITTINGS

A. Pipe shall be marked continuously with manufacturer's name, nominal pipe size, schedule or class, PVC type and grade, National Sanitation Foundation approval, Commercial Standards designation, and date of extrusion.

B. All plastic pipe shall be extruded of an improved PVC virgin type pipe compound in accordance with ASTM D2672, ASTM D2241 or ASTM D1785.

C. All solvent weld PVC fittings shall be standard weight Schedule 40 (and Schedule 80 where specified on the irrigation detail sheet, all mainline fittings shall be Leemco fittings) and shall be injection molded of an improved virgin PVC fitting compound. Slip PVC fittings shall be the "deep socket" bracketed type. Threaded plastic fittings shall be injection molded. All tees and ells shall be side gated. All fittings shall conform to ASTM D2464 and ASTM D2466.

D. All threaded nipples shall be standard weight Schedule 80 with molded threads and shall conform to ASTM D1785.

E. All solvent cementing of plastic pipe and fittings shall be a two-step process, using primer and solvent cement applied per the manufacturer's recommendations. Cement shall be of a fluid consistency, not gel like or ropy. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.

F. When connection is plastic to metal, female adapters shall be hand tightened, plus one turn with a strap wrench. Joint compound shall be non-lead base. Teflon paste, tape, or equal.

G. All pressure mainlines installed with solvent weld PVC fittings shall be installed with concrete thrust blocking at all directional changes in the mainline routing. Concrete

thrust blocking shall not be required when ductile iron fittings and mechanical restraints are specified.

2.05 BELL AND GASKET FITTINGS

A. Fittings for bell and gasket pressure supply lines shall be ductile iron deep bell type. Fittings shall be manufactured of ductile iron, Grade 65-45-12 in accordance with ASTM A-536. Fitting gaskets shall be in accordance with ASTM F-477. All ductile iron fittings shall be manufactured with exterior lugs. Ductile iron fittings shall be as manufactured by Leemco, Inc. Corona, California.

B. All tee fittings used to connect remote control valve assemblies and quick coupler assemblies to the mainline shall be ductile iron deep bell type. The outlet side of the tee or ell to the valve assembly shall be sized per the diameter of the largest valve in the assembly or a minimum of 2 inches. Ductile iron deep bell type reducers when used with bolt on links are allowable in lieu of reducing tees or ells. The PVC pipe to the valve assembly shall be secured to the ductile iron fitting using a joint restraint.

C. All ductile iron fittings and all bell and gasket joints within fifty (50) feet of a directional change in the mainline shall be equipped with mechanical joint restraints. The joint restraint shall be capable of securing the PVC pipe directly to the lugs on the ductile iron fittings without the use of bolts, links or adapters. The joint restraint shall be capable of securing PVC pipe to PVC pipe and PVC pipe to ring joint isolation valves without the use of threaded linkages. Joint restraints shall be as manufactured by Leemco, Inc., Corona, California.

2.06 VALVES

A. Gate Valves:
   1. Gate valves shall be of the manufacturer, size and type indicated on the irrigation drawings.
   2. All gate valves shall have a minimum working pressure of not less than 150 PSI and shall conform to AWWA standards.

B. Quick Coupler Valves:
   1. Quick coupler valves shall be of the manufacturer, size, and type indicated on the irrigation drawings.
   2. Quick coupler valves shall be brass with a wall thickness guaranteed to withstand normal working pressure of 150 psi without leakage. Valves shall have 1" female threads opening at base, with two-piece body. Valves to be operated only with a coupler key, designed for that purpose. Coupler key is inserted into the valve and a positive, watertight connection shall be made between the coupler key and valve.

C. Automatic Control Valves:
   1. Automatic control valves shall be of the manufacturer, size, and type indicated on the drawings and installed with one decoder each.

2. Automatic control valves shall be electronically operated.

2.07 VALVE BOXES

A. Valve boxes shall be fabricated from concrete material resistant to sunlight and chemical action of soils.

B. The valve box cover shall be cast iron and secured with a hidden latch mechanism or bolts.

C. The cover and box shall be capable of sustaining a load of 1,500 pounds.

D. Valve box extensions shall be by the same manufacturer as the valve box.

E. Automatic control valve boxes shall be 16"x11"x12" 'nominal' rectangular size. Valve box covers shall be marked "RCV" with the valve identification number, or "MV", "FS" "heat branded" onto the cover in 1 1/4 inch high letters/numbers.

F. Drip flush valve and air relief valve boxes shall be 6" circular size. Valve box covers shall be marked with "FV" or "ARV" "heat branded" onto the cover in 1 ¼ inch letters.

2.08 GROUND ROD

A. Ground rod shall be 5/8 inch X 8 foot copper clad.

2.09 BACKFLOW PROTECTION DEVICE

A. Field verify working order of existing backflow device serving pressure main line supply to point of connection.

2,10 TRACER WIRES

A. Tracer Wires: A No. 14, Green, Type TW plastic-coated copper tracer wire shall be installed with non-metallic irrigation main lines.

2.11 AUTOMATIC CONTROLLER

A. All new remote control valves shall be connected to existing controller. See irrigation plans for approximate location. Field verify exact location.

B. Controller shall be grounded according to local codes using equipment of the manufacturer, size, and type indicated on the drawings; or as required by local codes and ordinances.

2.12 ELECTRICAL

A. All electrical equipment shall be NEMA Type 3, waterproofed for exterior installations.

B. All electrical work shall conform to local codes and ordinances.

2.13 LOW VOLTAGE CONTROL WIRING

A. Remote control wire shall be two wire control cable TW-CAB-14 using straight line configuration.

B. Connections shall be of the manufacturer, size, and type indicated on the drawings.

2.14 IRRIGATION HEADS AND DRIP EMITTERS AND INLINE DRIP TUBING:

A. Irrigation heads, drip emitters and inline drip tubing shall be of the manufacturer, size, type, with radius of throw, operating pressure, and discharge rate indicated on the irrigation drawings.

B. Irrigation heads, drip emitters and inline drip tubing shall be used as indicated on the irrigation drawings.

2.15 DRIP IRRIGATION EQUIPMENT

A. Drip tubing equipment such as flush valves, air relief valves, wye strainers and pressure regulators shall be of the manufacturer, size and type indicated on the drawings.

2.16 MISCELLANEOUS EQUIPMENT

A. Landscape Fabric:
   1. Landscape fabric for valve box assemblies shall be 5.0- oz. weight woven polypropylene weed barrier. Landscape fabric shall have a burst strength pf 225 PSI. a puncture strength of 60 lbs. and capable of water flow of 12 gallons per minute per square foot.
   2. Type: DeWitt Pro 5 Weed Barrier or approved equal.

B. Equipment such as flow sensors, rain sensors, flush valves, air relief valves, and wye strainers, shall be of the manufacturer, size and type indicated on the irrigation drawings.

PART 3 EXECUTION

3.01 SITE CONDITIONS

A. Inspections:
   1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
   2. Verify that irrigation system may be installed in strict accordance with all

pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.

B. Discrepancies:
   1. In the event of discrepancy, immediately notify the Owner.
   2. Do not proceed with installation in areas of discrepancy until all discrepancies have been resolved.

C. Grades:
   1. Before starting work, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths with respect to finish grade.
   2. Final grades shall be accepted by the Architect before work on this section will be allowed to begin.

D. Field Measurements:
   1. Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design. Contractor shall coordinate the installation of all irrigation materials with all other work.
   2. All scaled dimensions are approximate. The Contractor shall check and verify all size dimensions prior to proceeding with work under this section.
   3. Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities, which are caused by his operations or neglect.

E. Diagrammatic Intent:

   The drawings are essentially diagrammatic. The size and location of equipment and fixtures are drawn to scale where possible. Provide offsets in piping and changes in equipment locations as necessary to conform with structures and to avoid obstructions or conflicts with other work at no additional expense to the Owner.

F. Layout:

   1. Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of sprinkler heads, valves, and automatic controller.
   2. Layout irrigation system and make minor adjustments required due to differences between site and drawings. Where piping is shown on drawings under paved areas, but running parallel and adjacent to planted areas, install the piping in the planted areas.

G. Water Supply:

   Connections to, or the installation of, the water supply shall be at the locations shown on the drawings. Minor changes caused by actual site conditions shall be made at no additional expense to the Owner.

H. Electrical Service:
   1. Connections to the electrical supply shall be at the locations shown on the irrigation drawings. Minor changes caused by actual site conditions shall be made at no additional expense to the Owner.
   2. Contractor shall make electrical connections to the existing Rain Master irrigation controller.

3.02 TRENCHING

A. Excavations shall be straight with vertical sides, even grade, and support pipe continuously on bottom of trench. Trenching excavation shall follow layout indicated on drawings to the depths below finished grade and as noted. Where lines occur under paved areas, these dimensions shall be considered below subgrade.

B. Provide minimum cover of 24 inches on pressure supply lines 3 inches and larger.

C. Provide minimum cover of 18 inches for control wires.

D. Provide minimum cover of 36 inches on pressure supply lines under vehicular travel ways.

E. Provide minimum cover of 12 inches for non-pressure lines.

F. Pipes installed in a common trench shall have a 4-inch minimum space between pipes.

3.03 THRUST BLOCK

A. Thrust blocks must be constructed of Class "B" concrete.

B. Thrust blocks must be poured against undisturbed site soil.

C. PVC fitting joints shall be kept free of concrete. Do not encase fitting in concrete.

D. Thrust blocking shall be sized to provide the minimum bearing areas as shown below. Bearing areas indicated have been calculated for Class 200 PVC pipe at a test pressure of 150 PSI in soil with 2,000 PSI bearing capacity. Increase thrust block sizing as necessary for varying soil conditions.
   1. Provide a minimum thrust block bearing area of 2.0 square feet on all bends (all degrees) and tees installed on pressure supply lines 4 inches and smaller.
   2. Provide a minimum thrust block bearing area of 4.0 square feet on all 90 degree bends installed on pressure supply lines 6 inches in size.

3.04 BACKFILLING

A. Backfill material on all lines shall be the same as adjacent soil free of debris, litter, and rocks over ½ inches in diameter.

B. Backfill shall be tamped in 4-inch layers under the pipe and uniformly on both sides for the full width of the trench and the full length of the pipe. Backfill materials shall be sufficiently damp to permit thorough compaction, free of voids. Backfill shall be compacted to dry density equal to adjacent undisturbed soil and shall conform to adjacent grades.

C. Flooding in lieu of tamping is not allowed.

D. Under no circumstances shall truck wheels be used to compact backfill.

E. Provide sand backfill a minimum of 4 inches over and under all piping under paved areas.

3.05 PIPING

A. Cutting or breaking of existing pavement is not permitted.

B. Carefully inspect all pipe and fittings before installation, removing dirt, scale, burrs, and reaming. Install pipe with all markings up for visual inspection and verification.

C. Remove all dented and damaged pipe sections.

D. All lines shall have a minimum clearance of 4 inches from each other and 12 inches from lines of other trades.

E. Parallel lines shall not be installed directly over each other.

F. In solvent welding, use only the specified primer and solvent cement and make all joints in strict accordance with the manufacturer's recommended methods including wiping all excess solvent from each weld. Allow solvent welds at least 15 minutes setup time before moving or handling and 24 hours curing time before filling.

G. PVC pipe shall be installed in a manner, which will provide for expansion and contraction as recommended by the pipe manufacturer.

H. Center load all plastic pipe prior to pressure testing.

I. All threaded plastic-to-plastic connections shall be assembled using Teflon tape or Teflon paste,

K. For plastic to metal connections, work the metal connections first. Use a non-hardening pipe dope on all threaded plastic-to-metal connections, except where noted otherwise. All plastic-to-metal connections shall be made with plastic female adapters.

3.06 CONTROLLER

A. The Contractor shall be responsible for the final electrical hook up to the existing

irrigation controller.

B. The irrigation system shall be programmed to operate during the periods of minimal use of the design area.

3.07 CONTROL WIRING

A. Low voltage control wiring shall occupy the same trench and shall be installed along the same route as the pressure supply lines whenever possible.

B. Where more than one wire is placed in a trench, the wiring shall be taped together in a bundle at intervals of 10 feet. Bundle shall be secured to the mainline with tape at intervals of 20 feet.

C. All connections shall be of an approved type and shall occur in a valve box. Provide an 18-inch service loop at each connection.

D. An expansion loop of 12 inches shall be provided at each wire connection and/or directional change, and one of 24 inches shall be provided at each remote control valve.

E. A continuous run of wire shall be used between a controller and each remote control valve. Under no circumstances shall splices be used without prior approval.

3.08 VALVES

A. Automatic control valves, quick coupler, and gate valves are to be installed in the approximate locations indicated on the drawings.

B. Valve shall be installed in shrub areas whenever possible.

C. Install all valves as indicated in the planting and irrigation details drawing.

D. Valves to be installed in valve boxes shall be installed one valve per box.

3.09 VALVE BOXES

A. Valve boxes shall be installed in shrub areas whenever possible.

B. Each valve box shall be installed on a foundation of ¾ inch gravel backfill, 3 cubic feet minimum. Valve boxes shall be installed with their tops ½ inch above the surface of surrounding finish grade in lawn areas and 2 inches above finish grade in ground cover areas.

3.10 IRRIGATION HEADS DRIP EMITTERS AND INLINE DRIP TUBING

A. Irrigation heads, drip emitters and inline drip tubing shall be installed as indicated on the planting and irrigation details drawing.

B. Spacing of heads and inline drip tubing shall not exceed maximum indicated on the drawings.

C. Riser nipples shall be of the same size as the riser opening in the sprinkler body.

3.11 MISCELLANEOUS EQUIPMENT

A. Install all assemblies specified herein according to the respective detail drawings or specifications, using best standard practices.

B. Quick coupler valves shall be set approximately 18 inches from walks, curbs, header boards, or paved areas where applicable.

C. Install devices such as rain sensors, flush valves, air relief valves, master valves and flow sensors as indicated on the drawings and as recommended by the manufacturer.

3.12 FLUSHING THE SYSTEM

A. Prior to installation of irrigation heads, the valves shall be opened and a full head of water used to flush out the lines and risers.

B. Irrigation heads shall be installed after flushing the system has been completed.

3.13 ADJUSTING THE SYSTEM

A. Contractor shall adjust valves, align heads, and check the coverage of each system prior to coverage test.

B. If it is determined by the Owner that additional adjustments or nozzle changes will be required to provide proper coverage, all necessary changes or adjustments shall be made prior to any planting.

C. The entire system shall be operating properly before any planting operations commence.

D. Automatic control valves are to be adjusted so that the irrigation heads, drip emitters and inline drip tubing operate at the pressure recommended by the manufacturer.

3.14 TESTING AND OBSERVATION

A. Do not allow or cause any of the work of this section to be covered up or enclosed until it has been observed, tested and accepted by the Owner and governing agencies.

B. The Contractor shall be solely responsible for notifying the Owner a minimum of 48 hours in advance, where and when the work is ready for testing.

C. When the sprinkler system is completed, the Contractor shall perform a coverage test of each system in its entirety to determine if the water coverage for the planted areas is complete and adequate in the presence of the Owner.

D. The Contractor shall furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from the plans, or where the system has been willfully installed as indicated on the drawings when it is obviously inadequate, without bringing this to the attention of the Owner. This test shall be accepted by the Owner and accomplished before starting any planting.

E. Areas to be maintained for the formal maintenance period shall start maintenance at the same time as directed by the Owner. Partial areas will not be released into maintenance prior to completion of items listed in the pre-maintenance review. The maintenance period may not be phased.

F. If, after the maintenance review, the irrigation systems are not accepted by the Owner, the Contractor shall reimburse the Architect for additional site visits, or additional time required to review work. All additional time will be billed at the Architect's hourly rate and will be paid for by the Contractor at no additional cost to the Owner.

G. Final inspection will not commence without record drawings as prepared by the Contractor.

3.15 MAINTENANCE

During the maintenance period the Contractor shall adjust and maintain the irrigation system in a fully operational condition providing complete irrigation coverage to all intended plantings.

3.16 COMPLETION CLEANING

Clean up shall be made as each portion of the work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be swept, and any damage sustained on the work of others shall be repaired to original conditions.

END OF SECTION 328000

SECTION 329000 – LANDSCAPE PLANTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Landscaping.

B. Related work specified elsewhere.

1. Landscape Irrigation. (328000)

2. Landscape Maintenance. (320190)

1.02 SUBMITTALS

A. Approvals.

1. Provide written evidence that landscape irrigation system has been inspected and approved prior to start of any work of this section.
2. Agronomic Soil Report
   a. Contractor shall, at his expense, obtain a soils test report from an approved professional agronomic soils testing laboratory. Contractor shall submit the name, address and phone number of the consulting soil testing laboratory for approval prior to obtaining services.
   b. The approved soil testing laboratory report shall indicate soil analysis for plant growth suitability, including permeability rate and recommendations for soil preparation in all planting areas and soil mix for backfill of planting container material.
   c. The recommendations of the agronomic soil report shall take precedence over the quantities of soil amendments and material mix specified in the backfill mix and only when those specifications exceed the minimum requirements specified herein.
   d. Contractor shall submit one (1) copy of the agronomic soil report to the Architect and shall not begin any landscape planting work until the report has been evaluated and approved by the Architect.

PART 2 PRODUCTS

2.01 MATERIALS

A. Soil fumigant. For pre-planting treatment to kill soil fungi, nematodes, weeds and weed seed, both annual and perennial and soil insects as approved by the Architect.

B. Fertilizer.
1. Commercial type.

a. 10-6-4. Standard commercial brand.
b. Calcium nitrate, standard commercial brand.
c. 21-3-5. Standard commercial brand.

2. Soil conditioner - fertilizer type. ("GRO-POWER" as manufactured by Southern California Organic Fertilizer Co., Inc.).
   a. "Gro-Power" guaranteed analysis 5-3-1, 50% humus, 15% humic acid with bacteria included. No poultry, animal or human waste acceptable. Material will be bagged in 50 lb. bags.
   b. "Gro-Power" Controlled Release guaranteed analysis 12-8-8, 25% humus, 5% humic acids with bacteria included. No poultry, animal or human waste acceptable. Material will be bagged in 40 lb. bags.

C. Agricultural gypsum. Minimum consistency of CaSO4H2O - 97% with a typical screen analysis of 85% minus 100 mesh.

D. Soil sulfur. To consist of 99% pure sulfur. 99% of particles passing a 1/8" screen.

E. Activated charcoal. "Gro-Safe" as manufactured by ICI United States, Inc. Specialty Chemical Division.

F. Plant material.
1. Trees, shrubs, ground covers and sod.
   a. Refer to landscape planting plan for plant list.
   b. Size as per planting plan plant list. Condition - American Nursery Standards.
   c. Quality.
      1) Healthy, shapely, well rooted, disease and insect free, not deformed or root bound.
      2) Grown in nurseries inspected by State Department of Agriculture.
      3) Free of abrasions, knots, injuries or disfigurations.
   d. Label or tag one of each variety of plant with proper botanical name identifying genus, species and (if applicable) variety.
2. Inspection and approval.
   a. Inspection location.
      1) Required upon delivery to site. All plants are to be inspected approved at the project site.
   b. Plants not approved by AOR are to be removed from site immediately, and replaced with plants deemed suitable by the Owner at the contractor's expense.
   c. The Owner shall have the right to inspect and reject unsatisfactory or defective plant material at any time during the progress of the work.
3. Grass sod to be fresh, clean sod as noted on the plans.

G. Nitrogen stabilized wood shavings fine grade containing 1% nitrogen added to each lb. of shavings.

H. Prepared mulch shall be ½" redwood bark or ½" cedar bark.

I. Prepared backfill mix shall consist of:

Imported topsoil	- 6 parts by volume
Wood shavings	- 4 parts by volume
Soil conditioner/fertilizer ("Gro-Power" 5-3-1)	- 17 lb. per cu. yd. of mix
Agricultural gypsum	- 10 lb. per cu. yd.of mix
Activated charcoal	- Qty. as recommended ("Gro-Safe") by manufacturer.

VERIFY USE OF CHARCOAL.

J. Pre-Emergence herbicide to be broad spectrum approved by the Architect.

K. Post-Emergence herbicide to be broad spectrum approved by the Architect.
1. Contact weed killer that does not leave a stain or residue.
2. Weed killer which utilizes the biological process of 'Translocation' to destroy all parts of the treated weed.

PART 3 EXECUTION

3.01 SOIL PREPARATION AND FINISH GRADING OF ALL PLANTING AREAS
(Includes lawn, sod, ground cover, trees and shrubs)

A. All planting areas, shall be thoroughly "ripped" to a depth of 12", using a ripper with teeth no wider than 12" O.C. The "ripping" shall be performed in two (2) directions unless contractor can show just cause for not proceeding in this manner.
1. Prior to "ripping" soil, remove all vegetation (not shown to remain), stumps, roots, rocks, stones (larger than 1" in diameter) and all other deleterious material.
2. Thoroughly moisten soil and grade all planting areas to within one-tenth of a foot of finished grades prior to incorporating soil amendments.

B. Spread six (6) cu. yds. of shavings, and 12 lbs. of (10-6-4) commercial fertilizer per 1000 sq. ft. Cultivate to a depth of 6" in two (2) directions so shavings are uniformly mixed.

C. Cultivate planting areas, except slopes steeper than 4:1, to a depth of 6". Fine grade planting areas so that there are no humps and hollows, and so that areas drain properly. All flow lines, designated or not, shall be graded and maintained to allow free flow of surface runoff. The finish grade of all planting areas shall be a min. of 1" below adjacent paving, curbs and mowing strips. If additional topsoil is required, Contractor to furnish good quality, approved soil from an off-site location.

3.02 PLANTS

A. Locating and planting of trees, shrubs and ground cover.
1. All plants are to be furnished and planted by the Contractor.

B. Plant pits. In instances where a mechanical digging device is used to excavate plant pits

rough "Score" vertical sides and bottom of plant pit to loosen soil to eliminate "Glazed" sides and bottom.

1. Plant containers are to be placed in a planting pit having vertical sides and be three (3) times wider than the width of the plant ball.

C. Construction of plant-watering basins outside of lawn areas.
Construct a berm, 3" above finish grade, which forms a watering basin, with a level bottom, around each plant. Watering basin to be 1-1/2 times the diameter of plant ball.

D. Plants shall not be allowed to dry out before or while being planted. Keep exposed roots moist at all times during planting operations. Do not expose to the air except while being placed in the ground. Wilted plants, whether in place or not, will not be accepted and shall be replaced at the Contractor's expense.

E. Water plants immediately after planting and as specified within this section under the heading of "Watering."

F. Top dress all shrub planting areas with ½" redwood bark or ½" cedar bark mulch, 3" deep.

3.03 PREPARING AND PLANTING LAWN (Refer to paragraph on Soil Preparation and Finish Grading for all Planting Areas).

A. Grass sod. Sod bed to be finish graded and floated smooth, to present a neat and uniform appearance. Secure Architect approval of sod bed prior to installing sod; refer to paragraph on fine grading of lawn area.

1. Roll area lightly to provide uniform surface.
2. Moisten area before sod placement.
3. Lay sod and join butts and do not overlap edges.
4. Water lightly after placement of each ten strips.
5. Roll again with a light roller providing uniform sod surface after all sod is placed.
6. Water sod area thoroughly after all sod is placed getting water down to 10" depth.
7. Continue application of water to keep sod moist. The first 10 days after placement are critical and sod is to be kept moist.

3.04 WATERING

A. Apply water to all planted areas and plants, during operations and thereafter, until acceptance of work.

B. All plantings which cannot be watered efficiently with the existing water system shall be watered by means of a hose.

C. Immediately after planting, apply water to each tree, shrub, and vine by means of a hose. Apply water in a moderate stream in the planting hole until the material about the roots is completely saturated from the bottom of the planting pit to finish grade.

D. Following the planting of ground cover, each plant shall be immediately and thoroughly watered by means of a hose with a slow running stream of water.

E. Apply water in sufficient quantities, and as often as seasonal conditions require to keep the ground moist at all times and well below the root system of grass and all other planting. Exercise care to prevent over watering, flooding or excessive runoff.

3.05 MAINTENANCE/PLANT ESTABLISHMENT PERIOD

A. The entire project shall be cared for, to the satisfaction of the Owner in such a manner as to present a neat and clean condition at all times.

B. Maintain all plantings in a thriving condition, to the satisfaction of the Owner, for 90 calendar days after all foregoing work is completed and approved.
   1. During the 90 day maintenance period all plants and planted areas shall be kept well watered and weed free at all times. Weeds include Dallas and Johnson Grass.
   2. Upon completion of all planting operations, apply pre-emergent weed control over all ground cover and shrub areas in accordance with manufacturer's recommendations. Prior to completion of the 90 day maintenance period, cultivate all ground cover and shrub areas and provide an additional application of pre-emergent herbicide in accordance with manufacturers recommendations.
   3. Grass to be mowed with a reel-type mower equipped with rollers before it exceeds 2-1/2" in height. Grass to be cut to not less than 1-1/2". Do not mow wet grass. Remove any lawn clipping that pile up which would result in damaging lawn.
      a. After each cutting, the edge of the grass shall be trimmed to a neat and uniform line. Where trees or shrubs occur in lawn areas, turn the grass under and neatly edge 18" away from the plants. Lawn edges to be maintained in a good condition until acceptance of work.
      b. Grass in ground cover or shrub areas shall be removed.
   4. Control all harmful insects and fungi using appropriate insecticides and fungicides.

C. Workmen are not allowed to walk on lawn areas unnecessarily before, during or after sodding operations. Damaged or compacted lawn areas shall be re-cultivated or re-sodded at the Contractor's expense.

D. During the maintenance period, apply soil conditioner-fertilizer ("Gro-Power") controlled release (12-8-8) at the rate of 20 lbs. per 1000 sq. ft. uniformly over all shrub, ground cover and lawn areas.

E. Replacements. Immediately replace any and all plant material which, for any reason, dies, is unhealthy or is damaged. Any plant material that dies back and loses the form and size as originally specified shall be replaced even though they have taken root and are growing after the die-back. Replacement shall be made with plants as indicated or specified for the original planting. All replacement of plant material shall be at the expense of the Contractor.

F. Damage to planting areas shall be replaced and repaired immediately.
   1. Depressions caused by erosion, vehicles, bicycles or foot traffic to be filled with topsoil and leveled. Re-sod damage done to lawn areas.

G. Exterminate gophers and moles and repair damage as approved by Owner.

H. The Contractor will be relieved of maintenance work when the final 90 calendar day plant establishment work has been satisfactorily completed. If maintenance is unsatisfactory, Contractor shall maintain work beyond the 90 calendar day period until all planting is in a healthy thriving condition as determined by the Owner. Final acceptance of landscape work will relieve Contractor from maintaining all planting.

3.06 INSPECTION

A. Written notice requesting an inspection shall be submitted to the Owner at least 10 days prior to the anticipated date.
   1. Inspections to be performed by the Owner or Architect.
      a. Plant locations prior to excavation of plant pits.
      b. Lawn areas, prior to sod installation.
      c. All landscape construction items, prior to the start of the 90 calendar day maintenance period.
         (1) Contractor shall insure that all landscape construction items are properly placed, all plants are in place in a healthy condition, areas are clean and free of weeds and debris, and entire area is in a neat condition prior to scheduling an inspection for beneficial occupancy at the beginning of the maintenance period and all subsequent inspections.
      d. During required fertilizer application within the maintenance period.
      e. At completion of 90 calendar day maintenance period.

END OF SECTION 329000

SECTION 331000 - WATER DISTRIBUTION

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 piping and specialties for combined potable and fire protection water service outside the building.

B. Related Sections include the following:
   1. Section 312000 - Earthwork for trench excavation and backfill.
   2. Drawings for potable and fire protection piping inside the building.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Working Pressures: The following are minimum pressure requirements for piping and specialties, unless otherwise indicated:
   1. Potable Water and Fire Protection Water Service: 200 psig (1380 kPa).

1.4 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 the following:
   1. Pipe, joint restraints and fittings.
   2. Valves and covers
   3. Backflow preventer
   4. Fire Department Connection

C. Purging and Disinfecting Reports: As specified in "Cleaning" Article in Part 3.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," for materials, installations, tests, flushing, and valve and hydrant supervision.

B. Comply with NSF Standard 61, "Drinking Water System Components", for material, installation, and testing requirements.

C. Comply with City of Newport Beach requirements for tapping of water mains.

D. Comply with City of Newport Beach standards for potable water-service piping for testing and disinfections.

E. Comply with City of Compton Fire Department installation and testing requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage to threaded ends and flange faces.
   3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves according to the following:
   1. Do not remove end protectors, unless necessary for inspection; then reinstall for storage.
   2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

1.7 PROJECT CONDITIONS

A. Verify existing utility locations and meters. Contact utility locating service.

B. Verify that it is possible to install water service piping to comply with original design and referenced standards.

C. Site Information: Reports on subsurface condition investigations made during design of Project are available for informational purposes only; data in reports are not intended as representations or warranties of accuracy or continuity of conditions between soil borings. Owner assumes no responsibility for interpretations or conclusions drawn from this information.

D. Obtain necessary connection permits with local water company as required.

E. Obtain necessary street excavation and encroachment permits from the City of Newport Beach Dept. of Public Works.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate piping materials, sizes, entry locations, and pressure requirements with building water distribution piping.

B. Coordinate piping materials, sizes, entry locations, and pressure requirements with building fire-protection water piping.

C. Coordinate with other site utility work.

PART 2 PRODUCTS

2.1 PIPES AND TUBES

A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.

B. PVC Plastic, Socket Fittings: ASTM D 2466, Schedule 40.

C. PVC Plastic, Fire Service Pipe: UL 1285 and AWWA C900, Class 200. Include elastomeric seal according to ASTM F 477.

D. Pipe sizes up to 2 inches shall be copper water tubing, Type K hard, ANSI H23.1, ASTM B 88, IAPMO IS. Muller Brass, Cambridge-Lee Halstead, or equal. an approved protective wrap shall be used to completely isolate and protect all underground copper tubing and extend past the surface a minimum 12 inches. The excess wrapping shall be trimmed down and taped to copper tubing with 10 mill PVC pipe tape at grade level of concrete or asphalt.

E. Ductile-Iron, Push-on-Joint Pipe: AWWA C151, with cement-mortar lining and seal coat according to AWWA C104. Include rubber compression gasket according to AWWA C111.

2.2 PIPE AND TUBE FITTINGS

A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.

B. Copper Fittings: ASME B16.22; wrought-copper, solder-joint pressure type.

C. PVC Plastic, Socked Fittings: ASTM D2466, Schedule 40.

D. Ductile-Iron, Push-on-Joint Fittings: AWWA C110, ductile-iron or cast-iron; or AWWA C153, ductile-iron, compact type. Include cement-mortar lining and seal coat according to AWWA C104 and rubber compression gaskets according to AWWA C111.

2.3 JOINING MATERIALS

A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.

B. Solder Filler Metal: ASTM B 32, Alloy Sn95, Alloy Sn94, or Alloy E, with 0.10 percent maximum lead content.

C. Primers for PVC Piping Solvent-Cement Joints: ASTM F 656.

D. Solvent Cement for PVC Piping Solvent-Cement Joints: ASTM D 2564.

2.4 PIPING SPECIALTIES

A. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and corrosion.
   1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
   2. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.
   3. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum pressure to suit system pressures.
   4. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
      a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
   5. Dielectric Couplings: Galvanized-steel couplings with inert and non-corrosive thermoplastic lining, with threaded ends and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   6. Dielectric Nipples: Electroplated steel nipples with inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig (2070-kPa) working pressure at 225 deg F (107 deg C).

2.5 POLYETHYLENE ENCASEMENT

A. Polyethylene Encasement for Ductile-Iron Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch (0.20-mm) minimum thickness, tube or sheet.

2.6 VALVES

A. All Gate Valves, 4-Inch NPS (DN80) and Larger in size shall conform to AWWA Standard Specifications C500. All valves, including those over 12", shall be rated to a minimum working pressure of 200 psi. All valves shall be iron body, bronze mounted, double-disk, parallel scat gate valves. All valves shall open by turning the stem counterclockwise. Buried valves shall be non-rising type with O-ring seal equipped with 2 inch square operating nut, and shall be bituminous coated. End connections shall be flanged or mechanical joint as required for the type of pipe used. Buried valves shall have stem extensions to place operating nut within 6" of top of valve box.

B. Valve Boxes shall be precast concrete with cast iron traffic rated cover with lettering "WATER", bottom section with base of size to fit over valve and barrel approximately 5 inches (125 mm) in diameter, and adjustable cast-iron extension of length required for depth of bury of valve.
   1. Provide steel tee-handle operating wrench with each valve box. Include tee handle with one pointed end, stem of length to operate valve, and socket-fitting valve-operating nut. After installation of valve box cover and after installation of adjacent paving, if any, covers shall be sandblasted or wire-brushed as necessary and painted with bituminous black paint, unless another color is required by the Architect.

C. Indicator Posts: UL 789, FM-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of bury of valve. Posts above and including connection to riser shall be sandblasted, if necessary, after installation and painted red, unless another color is required by the Architect.

D. Tapping Sleeve and Tapping Valve: Complete assembly, including tapping sleeve, tapping valve, and bolts and nuts. Use sleeve and valve compatible with tapping machine.
   1. Tapping Sleeve: Cast- or ductile-iron, 2-piece bolted sleeve with flanged outlet for new branch connection. Sleeve may have mechanical-joint ends with rubber gaskets or sealing rings in sleeve body. Include sleeve matching size and type of pipe material being tapped and of outlet flange required for branch connection.

2.7 BACKFLOW PREVENTERS

A. General: Manufactured backflow preventers, of size indicated for maximum flow rate and maximum pressure loss indicated.

B. Working Pressure: 200 psig (1380 kPa) minimum, unless otherwise indicated.

C. 2-Inch NPS (DN50) and Smaller: Bronze body with threaded ends.

D. Interior Lining: AWWA C550, epoxy coating for backflow preventers with cast-iron or steel body.

E. Interior Components: Corrosion-resistant materials.

F. Strainer on inlet if strainer is indicated.

G. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

H. Reduced-Pressure-Principle Backflow Preventer: ASSE 1013, with OS&Y gate valves on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves for continuous-pressure application.
   1. Pressure Loss: 12 psig (83 kPa) maximum through middle third of flow range.
   2. Double Detector Check Assembly: 15 psi (103.75 kPa) entry loss.

I. Exterior Finish: Red or yellow (as directed by Water Purveyor or local Fire Department) alkyd-gloss enamel paint. Entire device above and including connection to riser shall be sandblasted, if necessary, after installation and re-painted.

Manufacturer	Model	Size
Cia-Val	RP-LEX	2",2 1/2",3",4",6",8",10"
Cia-Val	RP-2	3/4",1",1-1/4",1-1/2"
Cia-Val	RP4	6 "
Febco	825YD2	2-1/2",3",4",6",8",10"
Febco	825Y	3/4",1",1-1/4",1-1/2",2"

Febco	825YA	3/4",1",1-1/2",2"
Febco	845	3/4",1"
Mueller	H-9506	4",6",8",10"
Orion	80-0069	1-1/2"
Orion	BRP	3/4,1",3",4"
Orion	9-2929	2 "
Rain Bird	RPA-075-R	3/4"
Rain Bird	RPA-100-R	1"
Rain Bird	RPA-125-R	1-1/4"
Rain Bird	RPA-150-R	1-1/2"
Rain Bird	RPA-200-R	2"
Rain Bird	RPA-250-R	2-1/2"
Rain Bird	RPA-400-R	4 "
Rain Bird	RPA-600-R	6"
Rain Bird	RPA-800-R	8"
Rain Bird	RPA-1000-R	10"
Watts	909 PCQT	3/4"-2"
Watts	909HWQT	3/4",1",1-1/4",1-1/2",2"
Watts	909 PCRW	2-1/2"-10"
Watts	909 RW Bronze	2-1/2",3"
Watts	009QT	3/4",1",1-1/4",1-1/2",2"
Watts	009SSQT	3/4",1",1-1/4",1-1/2",2"
Wilkins	575A	3/4",1
Wilkins	575	3/4",1",1-1/4",1-1/2",2"
Wilkins	575 (MOD-III)	2-1/2",3",4",6"
Wilkins	575M	8" (4"x4"x8" manifold)
Wilkins	575M	10" (6"x6"x10" manifold)

2.7 FIRE DEPARTMENT CONNECTIONS

A. Exposed Fire Department Connections: UL 405, cast-brass body, with thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
   1. Connections: Two 2-1/2-inch NPS (DN65) inlets and 6-inch NPS (DN150) outlet.
   2. Inlet Alignment: Inline, horizontal.
   3. Finish Including Sleeve: Polished chrome-plated.
   4. Escutcheon Plate Marking: "AUTO SPKR."

2.8 ANCHORAGES

A. Concrete Reaction Backing: Portland cement concrete mix, 2000 psig (13.8 MPa).
   1. Cement: ASTM C 150, Type I.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

2.9 IDENTIFICATION

A. Refer to Division 2 Section "Earthwork" for underground warning tape materials.

B. Arrange for detectable warning tapes made of solid blue film with metallic core and continuously printed black-letter caption "CAUTION--WATER LINE BURIED BELOW."

C. Nonmetallic Piping Label: Engraved, plastic-laminate label at least 1 by 3 inches (25 by 75 mm), with caption "CAUTION--THIS STRUCTURE HAS NONMETALLIC WATER-SERVICE PIPING," for installation on main electrical meter panel.

PART 3 EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000 "Earthwork" for excavation, trenching, and backfilling.

B. Refer to Section 321216 "Asphaltic Concrete Paving" for cutting and patching of existing paving.

C. Refer to Section 321313 "Concrete Paving" for cutting and patching of paving.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications:

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.

C. Do not use flanges or keyed couplings for underground piping.

D. Fire-Protection Water-Service Piping: Use the following:

E. 1.4- to 8-Inch NPS (DN100 to DN200): UL 1285 and AWWA C900, Class 200. Include elastomeric seal according to ASTM F 477.

3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, 3-Inch NPS (DN80) and Larger: AWWA, gate valves, non-rising stem, with valve box.
   2. Underground Valves, 4-Inch NPS (DN100) and Larger: UL/FM, gate valves, non-rising stem, with indicator post.

3.4 JOINT CONSTRUCTION

A. Ductile-Iron Piping, Gasketed Joints for Fire-Service Piping: According to UL 194 and AWWA C600.

B. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, OD, and system working pressure. Refer to "Piping Systems - Common Requirements" Article below for joining piping of dissimilar metals.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Install piping as indicated, unless deviations to layout are approved in advance by the Architect.

B. Install components with pressure rating equal to or greater than system operating pressure.

C. Install piping free of sags and bends.

D. Install fittings for changes in direction and branch connections.

G. Piping Connections: Unless otherwise indicated, make piping connections as specified below:
1. Install dielectric fittings to connect piping of dissimilar metals.

3.6 SERVICE ENTRANCE PIPING

A. Extend water-service piping and connect to water-supply source and building water piping systems at outside face of building wall in locations and pipe sizes indicated.
1. Terminate water-service piping at building wall until building water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water piping systems when those systems are installed.

B. Sleeves and mechanical sleeve seals are specified in Drawings.

C. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.7 PIPING INSTALLATION

A. Make connections larger than 2-inch NPS (DN50) with tapping machine according to the following:
1. Install tapping sleeve and tapping valve according to manufacturer's written instructions.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Install gate valve onto tapping sleeve. Comply with AWWA C600. Install valve with stem pointing up and with cast-iron valve box.
4. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.

B. If hot tap is not possible, install cut-in tee with C-110 fittings.

C. Comply with NFPA 24 for fire-protection water-service piping materials and installation.

D. Install ductile-iron piping according to AWWA C600.
   1. Encase piping with PE film according to ASTM A 674 or AWWA C105.

   2. Install encasement per manufacturer's written instructions. Close seams and overlaps in the polyethylene tubes with polyethylene compatible adhesive tape. The tape shall be approximately two inches wide and shall have the ability to bond securely to a metal surface and the polyethylene material. Repair all rips, tears and other damage with suitable adhesive tape.

E. Bury piping with depth of cover over top at least 30 inches (750 mm) and according to the following:
   1. Under Driveways: With at least 36 inches (900 mm) cover over top.
   2. If trenching before rough grading is completed would result in a lesser depth of cover than specified above, then trenching for water piping installation shall not be done until the specified minimum cover depth can be effected. If construction traffic will be allowed to pass over completed water piping installations prior to finish paving, then a protective pavement blanket at least equivalent to the final pavement and base thickness shall be constructed within the vehicle access area for a minimum distance of three feet on either side of the pipe. As an alternative to the temporary pavement blanket, the water pipe shall be installed at a minimum of two (2) feet deeper than specified within construction traffic areas.

3.8 ANCHORAGE INSTALLATION

A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   1. Gasketed-Joint, Ductile-Iron, Potable-Water Piping: According to AWWA C600.
   2. Fire-Service Piping: According to NFPA 24.

B. Apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of installed ferrous anchorage devices.

3.9 VALVE INSTALLATION

A. General Application: Use mechanical-joint-end valves for 3-inch NPS (DN80) and larger underground installation. Use non-rising-stem UL/FM gate valves for installation with indicator posts.

B. AWWA-Type Gate Valves: Comply with AWWA C600. Install underground valves with stem pointing up and with cast-iron valve box.

C. UL/FM-Type Gate Valves: Comply with NFPA 24. Install underground valves and valves in pits with stem pointing up and with vertical cast-iron indicator post.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install fire department connection of type and features indicated.

3.11 IDENTIFICATION INSTALLATION

A. Install continuous plastic underground warning tape during back-filling of trench for underground water-service piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping.

3.12 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than 1-1/2 times working pressure for 2 hours.
   1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within above limits.

C. Prepare reports for testing activities.

3.13 CLEANING

A. Clean and disinfect water distribution piping as follows:
   1. Purge new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
   2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities, use procedure described in AWWA C651 or as described below:
      a. Comply with NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
         1) Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine. Isolate system or part thereof and allow to stand for 24 hours.
         2) Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
         3) Following allowed standing time, flush system with clean, potable water until chlorine does not remain in water coming from system.
         4) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports for purging and disinfecting activities.

END OF SECTION

SECTION 333100 - SANITARY DISTRIBUTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sanitary drainage piping, fittings and accessories.

B. Connection of building sanitary sewer drainage system to site sewer systems

C. Cleanout access.

1.2 REFERENCES

A. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

B. ASTM D3034 - polyvinyl chloride (PVC), SDR 35, for solvent-cemented or gasketed joints.

C. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

D. SSPWC - Standard Specifications for Public Works Construction, latest Edition.

1.3 REGULATORY REQUIREMENTS

A. Conform to Section 306, Standard Specifications for Public Works Construction, for materials and installation of Work of this Section.

1.4 SUBMITTALS

A. Shop drawings indicating dimensions, locations and elevations of manholes, cleanouts and sub-surface structures.

B. Product data for pipe and pipe accessories.

C. Inspection and test reports specified

1.5 PROJECT RECORD DOCUMENTS

A. Accurately record location of existing and proposed pipe runs, connections, manholes, cleanouts and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS

A. Gravity-Flow, Nonpressure Plastic Pipe: Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D 3034, SDR 35, for gasketed joints. Gaskets: ASTM F 477, elastomeric seal.

B. PVC pipe is for outside conditions.

C. Vitrified Clay Pipe (VCP) - pipe shall be "extra strength VCP" and shall comply with Section 207-8 of the Standard Specifications for Public Works Construction. Pipe shall be manufactured in accordance with ASTM C-700 and installed in accordance with ASTM C-12. Joints for Vitrified Clay Pipe shall comply with Section 208-2.3 of SSPWC and manufactured in accordance with ASTM C-425. All VCP pipe, fittings and couplings shall be clearly marked at an interval not to exceed 5 feet as follows:
   1. Nominal pipe diameter.
   2. VCP classification.
   3. Company, plant, shift ASTM, and date designation.
   4. Service designation or legend.

D. Reinforced Concrete Pipe and Fittings: ASTM C76 (ASTM C76M), Class III, Wall B, for gasketed joints.
   1. Gaskets: ASTM C443 (ASTM C443M), rubber.

E. Hub and Spigot, Cast-Iron Soil Pipe and Fittings: ASTM A74, Service class, gray cast iron for gasketed joints. Include ASTM C564, rubber compression-type gaskets.

F. Backwater Valves: Gray iron.

G. Cleanouts: PVC.

H. Corrosion-Protection Piping Encasement: LLDPE film.

I. Manholes: Standard precast concrete.
   1. Resilient pipe connectors.
   2. Reinforced-concrete grade rings.
   3. Protective coating.
   4. Manhole frames and covers, with protective coating.
   5. Manhole cover inserts.

2.2 PIPE ACCESSORIES

A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

B. Fittings: Same material as pipe, molded or formed to suit pipe size and end design, in required "T", bends, elbows, cleanouts, reducers, traps and other configurations required.

C. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D3034, SDR 35, for solvent-cemented or gasketed joints.
   1. Gaskets: ASTM F477, Elastomeric seals.
   2. Primer: ASTM F 656.
   3. Solvent Cement: ASTM D 2564

2.3 CLEANOUTS

A. Lid and Frame: Cast iron construction, removable lid, closed checkerboard grill lid design; nominal lid and frame diameter as required for pipe sizes. [SPPWC 204-2]

B. Manholes: SPPWC Standard Drawing 200-3

2.4 FILL MATERIAL

A. Bedding and Fill: As specified in Section 31 20 00 "Earthwork"

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut or excavation base is ready to receive work, excavations, dimensions and elevations are as indicated on Drawings.

B. Beginning of installation means acceptance of existing conditions.

C. Verify that existing invert elevations on site will allow proper tie in to new work with proper positive slope. Ascertain accuracy prior to trenching and installation of sanitary sewer system.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with approved fill material.

B. Remove large stones or other hard matter that could damage sewer pipe or impede consistent backfilling or compaction.

3.3 INSTALLATION - PIPE

A. Prior to commencing Work, Contractor shall pothole existing utilities at points of connection. Notify Architect in event of discrepancies.

B. Install pipe, fittings and accessories in accordance with Section 306, SSPWC and manufacturer's instructions. Seal joints watertight.

C. Concrete Pipe and Fittings: Install according to ACPA "Concrete Pipe Handbook". Provide the following seals:
   1. Round Pipe and Fittings: ASTM C443 (ASTM C443M), rubber gaskets.
   2. Elliptical Pipe: ASTM C877 (ASTM C877M), Type I, sealing bands.
   3. Arch Pipe: ASTM C877 (ASTM C877M), Type I, sealing bands.

D. Due to corrosive soils on-site, all below grade piping consisting of ferrous metals shall be given a high-quality protective coating, such as 18-mil plastic tape, extruded polyethylene, coal-tar enamel, or Portland cement mortar. Below-grade metals should be electrically insulated (isolated) from above-grade metals by means of dielectric fittings in ferrous utilities and/or exposed metal structures breaking grade.

E. Place pipe on bedding as specified in Section 31 23 33.

F. Lay pipe to slope gradient noted on Drawings with maximum variation from true slope of 1/8 inch in 10 feet.

G. Do not displace or damage pipe when compacting.

H. Connect to site sewer outlet system through installed sleeves.

I. Do not cover joints until lines have been tested and approved.

3.4 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Establish elevations and pipe inverts.

C. Mount lid and frame level in grout secured to top cone section to elevation indicated.

3.5 PROTECTION

A. Protect pipe cover from damage or displacement until backfilling operation is in progress.

3.6 TESTING

A. After installation, test each sanitary drain and/or sewer and each section between successive manholes for either infiltration or exfiltration. Test shall be conducted in accordance with Section 306 - Underground Conduit Construction of the Standard Specifications for Public Works Construction.

B. Where excessive ground water is encountered test the pipeline for infiltration.

C. When infiltration or exfiltration exceeds allowable amounts as set forth in the Section 306 formula, perform repairs or replacements as necessary to comply with the required limits.

3.7 CLEANING

A. Remove rubbish, debris, and waste materials and legally dispose of off the project site.

B. Clean dirt and superfluous materials from interior of piping. Flush with potable water

END OF SECTION

SECTION 334100 - STORM DRAINAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Reference Specification: Perform all work in accordance with applicable provisions of "Standard Specifications for Public Works Construction", 2012 Edition. Unless otherwise noted, mention herein of section numbers refers to sections of the Reference Specification. Where Reference Specification refers to "Agency", substitute the word "Owner". Where Reference Specification refers to "Engineer", substitute the word "Architect". Where Reference Specification is in conflict with these Specifications, these Specifications shall govern.

1.2 SUMMARY

A. This Section includes gravity-flow, non-pressure storm drainage pipe and drainage structures outside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Non-pressure, Drainage-Piping Pressure Rating: At least equal to system test pressure

1.4 SUBMITTALS

A. Product Data for the following:
   1. Pipe and fittings
   2. Storm water quality devices: catch basin insert filters
   3. Drain inlets

B. Shop drawings for pre-cast concrete structures. Include frames, covers, and grates.

C. Shop drawings for cast-in-place concrete or field-erected masonry structures. Include frames, covers, and grates.

D. Reports and calculations for design mixes for each class of cast-in-place concrete.

E. Coordination drawings showing structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench. Indicate interface and spatial relationship between piping and proximate structures.

F. Inspection and test reports specified in the "Field Quality Control" Article.

1.5 QUALITY ASSURANCE

A. Environmental Agency Compliance: Comply with regulations pertaining storm drainage systems.

B. Utility Compliance: Comply with regulations pertaining to storm drainage systems. Include standards of water and other utilities where appropriate.

C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Section "Product Requirements."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures in direct sunlight.

B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, pipe fittings, and seals from dirt and damage.

D. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Notify architect of potential utility conflicts prior to installation of pipe system.

B. Locate existing structures and piping to be closed and abandoned.

C. Prior to commencing construction in public right-of-way and connecting to any public storm drain systems, contractor shall contact the agency of authority and obtain necessary permits.

D. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
   1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without receiving Architect's written permission.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PVC PIPE AND FITTINGS

B. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-1 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

C. PVC Sewer Pipe and Fittings: Schedule 40 ASTM D 1785 and D 2665 with solvent cement joints conforming to ASTM D 2564.

2.3 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. Dallas Specialty & Mfg. Co.
      b. Fernco Inc.
      c. Logan Clay Products Company (The).
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. NDS Inc.
      f. Plastic Oddities, Inc.

D. Shielded Flexible 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.
   1. Manufacturers:
      a. Cascade Waterworks Mfg.
      b. Dallas Specialty & Mfg. Co.
      c. Mission Rubber Company; a division of MCP Industries, Inc.
      d. Any equivalent manufacturer.

E. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
   1. Manufacturers:
      a. Fernco Inc.
      b. Logan Clay Products Company (The).
      c. Mission Rubber Company; a division of MCP Industries, Inc.
      d. Any equivalent manufacturer.

2.5 SUB-DRAINAGE MATERIALS

A. Filter Fabric: Supplied by prefabricated drainage structure manufacturer, 4.5 oz/sq. yd. min.

B. Waterproof Sheeting: Polyvinylchloride sheeting, minimum 20 mils thick, with waterproof ahesive supplied or recommended by sheeting manufacturer.

C. Perforated Subdrain Plastic Pipe:
   1. Acrylonitrile-Butadiene-Styrene (ABS) Pipe: ASTM D 2751, with a maximum SDR of 35.
   2. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, with maximum SDR of 35 and with flexible elastomeric seal joint.
   3. Perforations: Perforations in ABS and PVC pipe shall be circular, not more than 5/16" or less than 3/16" in diameter, and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches center-to-center, along rows. The rows shall be approximately 1-1/2" inches apart and arranged in a staggered pattern so that all perforations lie at the mid-point between perforations in adjacent rows. The rows shall be spaced over not more than 90 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket and perforations shall continue at uniform spacing over the entire width of the pipe. Manufacturer's standard ABS or PVC pipe essentially meets these requirements and may be substituted upon approval. Wall thickness as required for earth loads and as approved by Soils Engineer, 4" diameter, Schedule 80, minimum.
   4. Acrylonitrile-butadiene-styrene (ABS) pipe shall be joined using solvent cement or elastomeric joints and shall be in accordance with ASTM D 2751.
   5. Polyvinyl Chloride (PVC) pipe joints shall be in accordance with ASTM D 3212.
   6. Furnish subsoil drainage pipe prewrapped or wrap pipe with Mirafi 140N Filter Fabric, or Bidim C22 or C28 fabric manufactured by Monsanto; or equal.

2.6 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   1. Diameter: 48 inches minimum, unless otherwise indicated.
   2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
   3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   4. Riser Sections: 4-inch minimum thickness, and of length to provide depth indicated.
   5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   6. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
   7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
   8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or

anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.

9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording "STORM DRAIN."
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48, Class 35 gray iron, unless otherwise indicated.

2.7 CONCRETE

B. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

C. Ballast and Pipe Supports: Portland cement design mix, 3250-psi minimum, with 0.45 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.9 CATCH BASINS

A. Standard Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete, of depth indicated, with provision for sealant joints. Precast units shall meet H-20 traffic loading condtions.
1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
2. Top Section: Eccentric-cone type unless flat-slab-top type is indicated.
3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16 (heavy traffic) structural loading unless otherwise indicated. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings, unless otherwise indicated.
1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

C. Triton Catch Basin Insert filters by Contech Stormwater Solutions Inc.

2.10 CLEAN OUTS

A. Cleanout Covers: Alhambra Foundry Company, Inc. Model No. A-1240 or A1242, heavy duty lamp pole frame and cover, or equal approved.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section "Earthwork."

3.2 IDENTIFICATION

A. Materials and their installation are specified in Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground structures.
   1. Use warning tapes or detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

A. General: Include Silt tight joints, except where water tight and soil tight joints are indicated.

B. Pipe Couplings: Use where indicated and where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
   1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure storm drain piping, unless otherwise indicated.
      a. Shielded flexible couplings for same or minor difference OD pipes.
      b. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground sewerage and drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed. Verify existing elevations prior to extensive excavating and notify Architect of any discrepancies. Contractor shall be liable for any premature construction which must be modified due to unforeseen existing conditions.

C. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections unless direct tap into existing storm drain is indicated.

F. Extend drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
   2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   4. Install Concrete Pipe and Fittings according to ACPA "Concrete Pipe Handbook" with the following seals. Concrete round pipe and fittings per ASTM C443 (ASTM C443M), rubber gaskets. Elliptical and Arch pipe: ASTM C877 (ATM C877M), Type I, sealing bands.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.5 PIPE JOINT CONSTRUCTION

A. General: Join and install pipe and fittings according to the following.

B. Install with top surfaces of components, except piping, flush with final finished surface.

C. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:
   1. Join solvent-cement-joint pipe and fittings with solvent cement according to ASTM D 2855 and ASTM F 402.
   2. Join pipe and gasketed fittings with elastomeric seals according to ASTM D 2321.
   3. Join profile pipe and ribbed drain pipe and gasketed fittings with elastomeric seals according to ASTM D 2321 and manufacturer's written instruction.
   4. Install according to ASTM D 2321.

D. System Piping Joints: Make joints using system manufacturer's couplings, except where otherwise specified.

E. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems' materials and dimensions.

3.6 TRENCH DRAINAGE SYSTEM INSTALLATION

A. Assemble and install components according to manufacturer's written instructions and as indicated.

B. Assemble and install components according to manufacturer's written instructions, ASME A112.3.1, and as indicated.

C. Install with top surfaces of components, except piping, flush with final finished surface.

D. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

E. Embed channel sections and appurtenances in a 4-inch (100-mm) minimum depth of concrete around bottom and sides.

F. Fasten grates to channel sections if indicated.

G. Assemble trench sections with flanged joints.

H. Embed trench sections and appurtenances in a 4-inch (100-mm) minimum depth of concrete around bottom and sides.

I. Make piping connections and install stainless-steel piping with gasketed joints between system components.

3.7 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated. Ensure catch basin walls are properly sealed at the drain pipe penetrations.

3.8 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's storm building drains specified in Division 22 Section "Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3250 psi.

3.9 FIELD QUALITY CONTROL

A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Test storm drain according to requirements of authorities having jurisdiction and the following:
      a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
      b. Close openings in system and fill with water.
      c. Purge air and refill with water.
      d. Disconnect water supply.
      e. Test and inspect joints for leaks.

6. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.
7. Air Tests: Test storm drainage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.

B. Leaks and loss in test pressure constitute defects that must be repaired.

C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Remove rubbish, debris, and waste materials and legally dispose of off the project site.

B. Clean dirt and superfluous materials from interior of piping. Flush with potable water.

END OF SECTION