United States
Department of
Agriculture

Forest Service

White River
National Forest
Aspen Sopris
Ranger District

July 2020

Aspen-Sopris Ranger District Office

Specifications

Volume 2 of 3

SECTION 220500
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 23, Common Work Results for Mechanical Systems.

END OF SECTION 220500

This page intentionally left blank.

SECTION 220523
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure
2. EPDM: Ethylene-propylene-diene terpolymer rubber
3. PTFE: Polytetrafluoroethylene plastic
4. SWP: Steam working pressure
5. TFE: Tetrafluoroethylene plastic

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Seismic Control Data: Submit all required information by the Delegated Design Professional in responsible charge of design for Seismic Controls for this project. Where specification section 23 05 48, “Wind, Seismic, and Vibration Controls” does not indicate any required seismic controls, no such submittal is required.

1.4 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for valves up to 125 psig and ASME B31.1 valves above 125 psig.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: Valves utilized to supply water for drinking or cooking purposes shall comply with NSF 372 and shall have a weighted average lead content of 0.25% or less.

D. Source Limitations: Obtain valves of a single type through one source from a single manufacturer.

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 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.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded or soldered ends.

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

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
2. Wrench: For plug valves with square heads. Furnish Government with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Ends.

1. Solder Joint: With sockets according to ASMEB16.18.

a. Caution: Use solder with melting point below 840°F for angle, check, gate, and globe valves; below 421°F for ball valves.
b. Threaded: With threads according to ASME B1.20.1.

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

2.3 BALL VALVES

A. Bronze Two-Piece Ball Valves:

1. Manufacturer and Model:

a. Threaded Ends:

1) Apollo 77CLF
2) Hammond UP8301A
3) Milwaukee UPBA400

b. Soldered Ends:

1) Apollo 77CLF
2) Hammond UP8311A
3) Milwaukee UPBA450

2. 150 psig SWP, non-shock 600 psig WOG, MSS SP-110, cast bronze, full port, two-piece body design, chrome-plated solid bronze ball with reinforced Teflon seats. Stem packing adjustable for wear with adjusting screw, NSF-372.

B. Hose End Valves:

1. Manufacturer and Model:

a. Threaded Ends:

1) Apollo 70LF-100HC Series
2) Nibco T-FP-600A-LF with hose end adaptor and cap

b. Soldered Ends:

1) Apollo 70LF-200HC
2) Nibco S-585-66-LF-HC

2.4 THERMOSTATIC BALANCING VALVES

A. Self-actuating thermostatic recirculation valve shall automatically and continuously maintain the end of each domestic hot water supply line at the specified water temperature. Valve shall regulate the flow of recirculated domestic hot water based on water temperature entering the valve regardless of system operating pressure. When fully closed, the valve shall bypass a minimum flow to maintain dynamic control of the recirculating loop and provide a means for system sanitizing. The valve shall be factory adjustable from 105°F to 140°F as required by project conditions. Thermal actuator shall be spring operated and self-cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits. Thermal actuator shall be rated for a minimum of 200,000 cycles. The valve shall comply with NSF 372.

1. Manufacturer and Model:

    a. Circuit Solver model CS
    b. approved equal

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

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

B. 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.

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

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

E. 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.

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

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service:

a. Water:

1) NPS 2 and Smaller: Ball valves

2. Balancing Service:

a. NPS 2 and Smaller: thermostatic balancing valve

3. Pump Discharge:

a. NPS 1-1/2 and Smaller: Bronze, Class 150, threaded

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

C. Domestic Cold Water, Domestic Hot Water, Domestic Hot Water Circulating, Non-potable Water: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Bronze, 2-piece, threaded or soldered
2. Check Valves:

a. Pump Discharge:

1) NPS 1-1/2 and Smaller: Bronze, Class 150, threaded

b. Other than Pump Discharge: Bronze, Class 150

1) NPS 2 and Smaller: Bronze, Class 150, threaded

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. All equipment and materials shall be installed in accordance with the recommendations of the manufacturer.

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

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

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

F. All valves shall be installed so they are accessible and serviceable. Install valves in position to allow full stem movement.

G. All valves shall be installed so the stem position is not more than 90-degrees from the vertical up position.

I. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

J. Isolation valves shall be installed:

1. In piping at each and every piece of equipment
2. In piping whenever said pipe enters or leaves an equipment room
3. At all branch take-offs from mains
4. Where shown on drawings

K. Valve identification requirements are in other Division 22 sections.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Soldered Joints: Use ASTM B813, water-flushable, lead-free flux; ASTM B32, lead-free-alloy solder; and ASTM B828 procedure, unless otherwise indicated

3.5 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.

END OF SECTION 220523

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPE AND EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Refer to section 230529, Hangers And Supports For Mechanical Systems

END OF SECTION 220529

This page intentionally left blank.

SECTION 220700
PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. The word "concealed" as used in this section refers to insulation in ceiling plenums, furred spaces, pipe and duct shafts, unheated spaces immediately below roof and crawl spaces. The word "exposed" refers to insulation in other areas.

1.3 SYSTEM DESCRIPTION

A. Systems to be Insulated: Insulate all portions of the following systems, equipment, and accessories, except where noted otherwise or furnished by OEM as part of equipment.

1. Cold Piping Systems:

a. Domestic cold water
b. Roof drain bowls, overflow drain bowls, roof drain leaders, overflow roof drain leaders, and storm water drains - horizontal only below roofline inside building, including roof drain bodies and the drop from the drain to the horizontal run
c. Piping and all cold surfaces (valve bodies, etc.) inside equipment
d. Fittings, valves, strainers, and check valves

2. Hot Piping Systems:

a. Domestic hot water piping
b. Domestic hot water circulation piping
c. Piping inside equipment
d. Fittings, valves, strainers, and check valves

3. Hot Equipment:

a. Hot water storage tanks and heaters (unless pre-insulated)

4. Items that need not be insulated:

a. Vert*i*cal storm water drain piping
b. Exposed chrome-plated piping to sinks, toilets, etc.
c. Flexible connectors, air chambers, drain lines from water coolers, and condensate drains

d. Factory pre-insulated equipment
e. Domestic hot water expansion tanks

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger

3. Detail insulation application at pipe expansion joints for each type of insulation
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation
5. Detail removable insulation at piping specialties, equipment connections, and access panels
6. Detail application of field-applied jackets
7. Detail application at linkages of control devices
8. Detail field application for each equipment type

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. 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. Storage and Protection: Protect insulation against dirt, water, chemical, or mechanical damage before, during, and after installation. Satisfactorily repair or replace such insulation or covering damaged prior to final acceptance of the work.

B. Packaging: Provide insulation material containers marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22, Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork shop drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for the required space for maintenance.

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 PIPE INSULATION

A. Manufacturers:

1. Armstrong World Industries
2. Certainteed Crimpwrap
3. Fibrex Insulations Inc.; Coreplus 1200
4. Knauf Insulation; 1000 Pipe Insulation
5. Manson Insulation Inc.; Alley-K
6. Owens Corning; Fiberglas Pipe Insulation
7. Johns Manville; Micro-Lok

B. Preformed fiberglass conforming to ASHRAE 90.1-2013, ASTM C547, Class I or II, and ASTM C585 with "K" factor of 0.23 Btu-in./h-sf-°F maximum at 75°F mean temperature. See schedule for thickness.

C. Provide factory-applied ASJ/SSL type, ASTM C921, or ASTM C1136, Type I jacket with vapor barrier for cold piping (below ambient), or Type II for hot piping (above ambient). Type I may be used for both at Contractor's option. Factory-applied flap adhesive (SSL) or conventional staple and tape seal at Contractor's option.

D. Pipe Insulation Thickness Schedule:

Piping System Type		Minimum Insulation Thickness for Pipe Sizes				
	From:		NPS 1	NPS 1-1/2	NPS 4	Greater than NPS 8
	To less than:	NPS 1	NPS 1-1/2	NPS 4	NPS 8	
1. Domestic cold water[1]		1/2”	3/4”	1”	1”	1”
2. Domestic hot water with and including recirculating loop (140°F and less)[1]		1”	1”	1-1/2”	1-1/2”	1-1/2”
3. Roof drain bowls and piping[1]		1/2”	1”	1”	1”	1.5”

Note 1: For piping exposed to outdoor ambient temperatures, increase thickness by 0.5 in.

E. Cover fittings and valves with premolded one-piece PVC-insulated covers. This product is not to be installed in locations where its use is prohibited by local codes.

F. Protect insulation on exterior piping exposed to the weather with weatherproof metal jacket. Provide jacket with 0.016-inch-thick aluminum with laminated vapor barrier. Provide "Z" groove in jacket to assure watertight seal. Seal each joint with snap straps containing permanently plastic sealing compound and secured by 1/2-inch-wide stainless steel bands.

2.2 ADHESIVES, MASTICS, AND SEALANTS – LOW VOC

1. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use sealants that 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," including 2004 Addenda.

2.3 ADHESIVES

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

B. ASJ Adhesive, and FSK and PVDC 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 the following:

a. Childers Brand, CP-82
b. Eagle Bridges - Marathon Industries; 225
c. Foster Brand 85-50

d. Mon-Eco Industries, Inc.; 22-25

C. PVC Jacket Adhesive: Compatible with PVC jacket.

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

a. Dow Corning Corporation; 739, Dow Silicone
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive
c. P.I.C. Plastics, Inc.; Welding Adhesive
d. Speedline Corporation; Polyco VP Adhesive

2.4 MASTICS

A. Provide materials compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use at below-ambient services.

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

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; 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°F.
4. Solids Content: ASTM D 1644, 58% by volume and 70% 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 the following:

a. Childers Brand; CP-30
b. Eagle Bridges - Marathon Industries; 501
c. Foster Brand; 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°F.
4. Solids Content: ASTM D 1644, 44% by volume and 62% 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 the following:

a. Childers Brand; Encacel
b. Eagle Bridges - Marathon Industries; 570
c. Foster Brand; 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°F.
4. Solids Content: ASTM D 1644, 33% by volume and 46% 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 the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; CP-10
b. Eagle Bridges - Marathon Industries; 550
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; 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°F.
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; CP-76
b. Eagle Bridges - Marathon Industries; 405
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; 95-44
d. Mon-Eco Industries, Inc.; 44-05

2. Provide materials compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250°F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; CP-76

2. Provide materials compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250°F.
5. Color: White.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Install insulation using workmen regularly engaged in this kind of work in strict accordance with the manufacturer's recommendations and recognized industry practices.

3.2 INSTALLATION

A. General:

1. Apply full-length units of insulation on clean, dry surfaces free of foreign matter. Apply only after tests and approvals required by the specifications have been completed.
2. Insulation on cold surfaces must be applied with a continuous, unbroken vapor seal. Supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.
3. Finish raw edges with finishing cement.

B. Pipe Insulation:

1. Provide continuous pipe insulation through walls and floor openings except where walls and floors are required to be fire-stopped or required to have a fire-resistance rating. Where this occurs, fill the open space remaining between the sleeve and pipe with fire-stop.
2. Butt joints firmly together and smoothly, secure self-sealing jacket laps and joint strips with monel staples at 6-inch o.c. and cover with lap adhesive or factory (SSL) adhesive.
3. Seal ends of cold pipe insulation with a vapor barrier coating at fittings and valves and at intervals of 21 feet on continuous runs of pipe.
4. Insulate cold pipes continuously through hangers. Provide rigid insulation inserts at pipe hangers and supports per Division 22 Section "Hangers and Supports for Plumbing Systems." Butt pipe insulation to the rigid insulation insert. Apply a wet coat of vapor barrier lap cement on butt joints and seal the joints with 3-inch-wide vapor barrier tape or band. Coat staples with heavy coat of brushed on vapor barrier lap cement.

C. Insulation on Fittings and Valves:

1. Where the factory premolded one-piece PVC insulated fitting covers are to be used, apply the proper factory precut insulation to the fitting using two layers for pipe

temperatures above 250°F or below 35°F. A single layer of insulation is suitable between 35°F and 250°F. Tuck the ends of the insulation snugly into the throat of the fitting with the edges adjacent to the pipe covering, tufted and tucked in, fully insulating the pipe fitting. Overlap the covers to the adjoining pipe insulation and jackets and seal all cold pipes at seam edges with vapor barrier adhesive. Seal the circumferential edges of covers with pressure sensitive tape. Overlap the tape on the jacket and the cover at least 1 inch.

2. At locations where the PVC covers are prohibited, use as an alternate one of the following methods: one-coat insulation cement, premolded fiberglass fitting covers, or mitered segments of pipe insulation. Provide glass fabric embedded in fire-retardant mastic finish. Use vapor barrier mastic for cold piping cold piping.
3. Valves may be insulated with sections of fiberglass pipe insulation complete with all service jacket. Coat raw ends with mastic, and use vapor barrier mastic for cold piping.

D. Pipe Insulation Exposed to Weather:

1. Install metal jacket using waterproof sealant as recommended by manufacturer, and secure with 1/2-inch-wide stainless steel bands. Insulate fittings with preformed or mitered sections of insulation material, covered with metal jacket, sealed, and secured with bands.

E. Hot Equipment Insulation:

1. Cut and miter insulation board to fit the contour of the vessel and tightly butt edges with joints staggered where two or more layers are necessary (due to available thickness of insulation). Secured with 1/2" x 0.015" galvanized steel bands on 12-inch centers or with weld pins or stick clips with washers on 18-inch centers.
2. Over the insulation, tightly stretch 1-inch galvanized wire mesh in place with edges tied together and finish with two coats of insulating cement troweled to a hard finish.

F. Other Requirements:

1. Do not insulate manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
2. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.
3. Repair damaged sections of existing plumbing insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation; install new jacket lapping and seal over existing.
4. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

END OF SECTION 220700

SECTION 220800
COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Cx process requirements for plumbing systems, assemblies, and equipment.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For pre-functional checklists, comply with requirements in various Division 22 Sections specifying plumbing and irrigation systems, system components, equipment, and products.

1.2 DEFINITIONS

A. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 SYSTEMS TO BE COMMISSIONED

1. Domestic hot-water heating system, including the following:
   a. Domestic hot-water piping, fittings, and specialties inside the building.
   b. Pumps, motors, accessories, and controls.
   c. Heaters, boilers, and tanks.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For plumbing testing technician.

B. Submittals: Submittals associated with commissioned systems.

C. Pre-Functional Checklists: Filled out pre-functional checklists. Pre-functional checklists are created by CxA for Contractor review.

D. Functional Performance Tests: Filled out functional performance test checklists for systems, assemblies, subsystems, equipment, and components to be part of the Cx process and according to requirements in Section 019113 "General Commissioning Requirements."

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing systems and components to include in operation and maintenance manuals.

B. Record of Training of operation and maintenance personnel of commissioned systems.

1.6 QUALITY ASSURANCE

A. Plumbing Testing Technician Qualifications: Technicians to perform plumbing construction checklist verification tests, construction checklist verification test demonstrations, and functional performance tests shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.
2. Minimum 2 years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Test equipment and instrumentation list, identifying the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.

2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

a. Be calibrated by manufacturer with current calibration tags permanently affixed.
b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 MEETINGS

A. Meetings held as part of the commissioning process will include plumbing systems as necessary.

3.2 SUBMITTALS

A. The CxA will provide appropriate the general contractor with a list of plumbing submittals to be reviewed.

B. The Contracting Officer will facilitate the distribution of plumbing submittals to the CxA.

C. The CxA will review plumbing submittals within 10 business days.

3.3 PRE-FUNCTIONAL CHECKLISTS

A. Review and provide written comments on draft Pre-Functional Checklists. CxA will create required draft Pre-Functional Checklists and provide them to the Contracting Officer for distribution to the contractor.

B. Return draft pre-functional checklist review comments within 10 business days of receipt.

C. When review comments have been resolved, the CxA will provide final Pre-Functional Checklists.

D. Mechanical, Electrical, and Controls contractors will fill out their respective sections of the pre-functional checklists and note any outstanding deficiencies.

E. Comply with Pre-Functional Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying plumbing systems and equipment.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. Prior to functional testing, checks for the following conditions will be made:
   1. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved submittals.
   2. Certify that plumbing systems instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved submittals, and that pretest set points have been recorded.
   3. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

B. Perform tests using design conditions, whenever possible.

   1. Simulated conditions may be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
   2. Functional Performance Test procedures may direct that set points be altered when simulating conditions is impractical.
   3. Functional Performance Test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
   4. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to the Contracting Officer. After deficiencies are resolved, reschedule tests.

C. Functional Performance Testing Common to Plumbing Systems
   1. Measure effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

2. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.
3. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
4. Comply with pre-functional checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Division 22 Sections specifying plumbing systems and equipment.
5. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
    a. Pre-functional checklists.
    b. Functional Performance Tests.

D. Supervision of Alarms in Plumbing Systems:

1. Prerequisites: Acceptance of results for Pre-functional checklists.

2. Test Purpose: Supervised plumbing system alarms.

3. Test Conditions: Verify reporting of supervised plumbing alarm at building management system related to systems to be commissioned.

4. Acceptance Criteria: Operation of equipment according to OPR and BOD.

END OF SECTION 220800

This page intentionally left blank

SECTION 221000
PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data: Provide submittals on all items furnished under this section including product data on piping materials, fittings, methods, and specialties.

B. Quality Assurance/Control Submittals: Provide test reports required under "Field Quality Control" and "Start-up Services."

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PLUMBING PIPING:

A. All components in contact with potable water shall be NSF 61 and NSF 372 certified. Where ever "lead free" occurs, the reference is to these standards.

2.2 DOMESTIC WATER PIPE, TUBE, FITTINGS, AND JOINTS

A. Copper Pipe:

1. Above Grade Pipe: ASTM B88, Type L drawn temper seamless copper tube, NSF-372 and NSF 61 certified.
2. Below Grade Pipe, NPS 3 and smaller: ASTM B88, Type K annealed temper, seamless copper tube.
3. Fittings: ASME B16.22 wrought copper, ASME B16.18 cast copper alloy, or wrought-copper Viega ProPress fittings with EPDM-rubber O-ring seal in each end. NSF-372 and NSF 61 certified.
4. Flanges: ASME B16.24, Class 150 cast bronze flanges with solder joint ends, NSF-372 and SF 61 certified.
5. Unions: ASME B16.18 cast copper alloy, hexagonal stock body with ball-and-socket joint, metal-to-metal seating surfaces, and solder joint and/or threaded ends, NSF-372 and NSF 61 certified.
6. Joints:

a. Solder Filler: ASTM B 32, Alloy Sn95, Sn94 or E; lead free, NSF 372 and NSF 61 certified.
b. Brazing Filler Metal: AWS A5.8 BcuP, copper phosphorus or BAg, silver classification.

2.3 BACKFLOW PREVENTER

A. Approved manufacturers are Apollo, Febco, and Wilkins.

B. Backflow Preventer: ASSE 1013, consisting of NRS gate valves, or ball valves for NPS 2and smaller, on the inlet and outlet and strainer on the inlet. Include test cocks and pressure differential relief valve having ASE A112.12 air-gap fitting located between two positive-seating check valve for continuous pressure application.

C. Provide backflow preventer of size shown on the drawings.

D. Backflow preventer shall be approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California and listed on the State of Colorado Cross-Connection Regulation Approval list.

E. Backflow preventer shall be provided with an upstream strainer.

2.4 SHOCK ABSORBERS

A. Approved manufacturers are Josam, Precision Plumbing Products, Smith, and Zurn.

B. Shock absorber shall have a factory-sealed, permanently charged compression chamber and internal expansion bellows.

C. Provide shock absorbers in accordance with Plumbing Drainage Institute (PDI) Standard WH 201.

2.5 FREEZE-PROOF WALL HYDRANTS

A. Approved manufacturers are Josam, Smith, Wade, Woodford, and Zurn.

B. Freeze-proof wall hydrant and hose bibb shall include a vacuum breaker.

C. Refer to the drawings for wall thickness on wall hydrants.

2.6 WATER PRESSURE REGULATORS

A. Approved manufacturers are Apollo, Mueller and Watts.

B. Provide type and capacity as indicated on the drawings.

C. Water pressure regulating valves shall be bronze body, rated at 200 psig (1,380 kPa) working pressure, with stainless steel seating ring, and shall conform to ASSE 1003.

2.7 WATER METERS

A. Approved manufacturers are Badger, Carlon, and Hersey.

B. AWWA C700, Displacement type with register reading in U.S. Gallons. Provide water meter suitable for the intended service and sized for the anticipated flow rates and volumes. Provide a contacting type meter with a contact setting of 10 gallons (38 liters) per contact.

2.8 TEMPERING CONTROLLERS

A. Approved manufacturers are Apollo, Lawler, Leonard, Powers, and Symmons.

B. Provide thermostatic water mixing valve of size shown on the drawings.

C. Mixing valve shall be capable of instant compensation for fluctuations in supply pressure and/or temperature of either supply to provide constant mixed water temperature at variable flow rates.

D. Mixing valve shall have automatic safety feature of safe shutdown in the event of failure of either the cold or hot supply.

E. Mixing valve trim shall include spring-loaded check valves, strainers, and screwdriver stops.

F. Valves shall be ASSE certified for their intended use.

2.9 DOMESTIC HOT WATER CIRCULATING PUMP

A. Approved manufacturers are Bell & Gossett, Grundfos, Taco, and Thrush. Pumps shall be certified lead-free and suitable for use in domestic water systems.

B. Provide all bronze or stainless steel in-line circulating pump of size and capacity as listed on the drawings.

C. Pump to have integral thermal overload protection.

D. Provide programmable, seven-day time clock with two cycles per day for seven days. Coordinate wiring with Division 26.

2.10 EXPANSION TANK

A. Acceptable manufacturers are Bell & Gossett, Apollo, Amtrol, Armstrong, Taco, and Watts.

B. Diaphragm Type Expansion Tanks: Provide pre-charged hydropneumatic steel expansion tank of the size and capacity shown on the drawings. ASME-rated for 125 psig working pressure.

2.11 INTERIOR SANITARY SEWER PIPE, FITTINGS, AND JOINTS

A. Above Grade Gravity Waste and Vent Pipe and Fittings:

1. Solid-wall PVC Pipe and Fittings:

a. Manufacturers:

1) Charlotte Pipe and Foundry
2) Harvel Plastics
3) Macon Plastics
4) National Pipe and Plastics, Inc.
5) North American Pipe Corporation
6) Spears Manufacturing

b. Pipe: ASTM D 1785 and ASTM D 2665, drain, waste, and vent, Schedule 40, NSF-14.

c. Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Below Grade Gravity Waste and Vent Pipe:

1. Solid-wall PVC Pipe and Fittings:

a. Manufacturers:

1) Charlotte Pipe and Foundry
2) Harvel Plastics
3) Macon Plastics
4) National Pipe and Plastics, Inc.
5) North American Pipe Corporation
6) Spears Manufacturing

b. Pipe: ASTM D 1785 and ASTM D 2665, drain, waste, and vent, Schedule 40, NSF-14.

c. Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

2.12 FLOOR DRAINS

A. Approved manufacturers are Josam, Smith, Zurn, Wade, and Watts.

B. Provide floor drains in accordance with the schedule shown on the drawings.

C. Provide a deep seal trap for each floor drain unless otherwise specified.

D. Provide flashing clamping devices for all drains located in slabs above ground.

2.13 TRAP PRIMER

A. Waterless Trap Protection:

1. Inline floor drain trap seals shall be ASSE 1072 approved.
2. Sure Seal or approved equal.

2.14 TRAPS

A. Provide traps for each plumbing fixture, floor drain, and other equipment requiring connection to the sanitary sewer system. Place each trap as near to the fixture outlet as practical. Trap material and type of connections shall be compatible with the connecting drainage system and be suitable for the intended application.

2.15 CLEANOUTS AND CLEANOUT ACCESS COVERS

A. Approved manufacturers are Josam, Smith, Zurn, and Wade.

B. Locations:

1. Rough-In Piping: Josam 58900, coated cast iron, ferrule and taper ABS plug with outlet type to match piping system.
2. Tile or Asphalt Floors: Josam 55000 coated cast iron, recessed top, floor cleanout, internal gasketed taper thread ABS plug, and adjustable housing.
3. Carpet Areas: Josam 55000, coated cast iron, adjustable collar with rolled thread and ABS countersunk plug, and scoriated secure round nikaloy cover.
4. Concrete Floors Without Finish in Mechanical Rooms and Garages: Josam 57000 less top with Josam , coated cast iron, internal gasketed, taper thread ABS plug, and adjustable housing with heavy-duty scoriated loose-set round cast iron tractor cover.
5. Exterior: Josam 55000-VP-22, coated cast iron, internal gasketed, taper ABS plug, and adjustable housing with heavy-duty scoriated loose-set round cast iron tractor cover. Spigot or NO-HUB connection.
6. Wall: Josam 58910, round stainless steel smooth wall access cover, center screw, coated cast iron cleanout ferrule with spigot connection, and recessed thread ABS plug.

2.16 VENT CAPS

A. Approved manufacturers are Josam, Smith, Wade, and Zurn.

B. Provide cast iron, vandal proof, hooded vent caps for all vent terminations. Vent cap shall be held in place with recessed allen head set screws.

2.17 INTERIOR STORM DRAINAGE PIPE, FITTINGS, AND JOINTS

A. Above Grade Gravity Storm Drainage Pipe and Fittings:

1. Solid-wall PVC Pipe and Fittings

a. Manufacturers

1) Charlotte Pipe and Foundry
2) Harvel Plastics
3) Macon Plastics
4) National Pipe and Plastics, Inc.
5) North American Pipe Corporation
6) Spears Manufacturing.

b. Pipe: ASTM D 1785 and ASTM D 2665, drain, waste, and vent, Schedule 40, NSF-14.
c. Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Joining Methods:

1. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to a.PVC solvent cement used on any portion of below grade pipe extending onto building envelope shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

a. Adhesive primer used on any portion of below grade pipe extending onto building envelope shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Solvent cement and adhesive primer used on any portion of below grade pipe extending onto building envelope 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."

2.18 ROOF AND OVERFLOW DRAINS

A. Approved manufacturers are Josam, Smith, Zurn, Wade, and Watts.

B. Provide roof drains in accordance with the schedule shown on the drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:

1. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installation.
2. Examine walls, floors, roofs, and plumbing chases for suitable conditions where piping and specialties are to be installed.
3. Do not proceed until unsatisfactory conditions have been corrected.

B. Domestic Water Service:

1. Make arrangements with the local water authorities, for connecting into the water distribution system and installing the water service as indicated on the drawings. Unless indicated otherwise on the drawings, connect building underground water supply to site utilities 5 feet outside the perimeter of the building.
2. Connect into the existing water piping as shown on the drawings. Coordinate with the Government for shutdown of existing water service.

C. Sanitary Sewer: Make arrangements with the local wastewater authorities, for connecting into the sanitary sewage collection system and installing the building sewer as indicated on the drawings. Unless indicated otherwise on the drawings, connect sanitary sewer to site utilities 5 feet outside the perimeter of the building.

3.2 INSTALLATION

A. General:

1. Provide bedding, anchors, thrust restrains/anchors, and restraints as appropriate and in accordance with manufacturer's recommendations based on type of pipe, fittings, joints, and bury depth using final finished grading as the basis. All drain pipes (sanitary and storm) over 4 inches shall be provided with restraints at all changes of direction and all changes of diameter greater than two pipe sizes. Braces, blocks, rodding and other suitable methods as specified by the coupling manufacturer shall be utilized.
2. Examine rough-in requirements for plumbing fixtures and other equipment having to verify actual locations of piping connections prior to installation.
3. Examine walls, floors, roofs, and plumbing chases for suitable conditions where piping and specialties are to be installed.
4. Piping shall be run true, plumb, and straight, with all restraints adjusted to carry their proportional load and locked to prevent pipe "wag," misalignment, movement, shear, or sagging.
5. Use fittings for all changes in direction and all branch connections.
6. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted unless expressly indicated.
7. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications. Piping hanger spacing and supports shall be per Code requirements (minimum) , or per Division 23 Section "Hangers and Supports for Mechanical Piping and Equipment," whichever is more stringent.
8. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors unless indicated to be exposed to view.
9. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Allow sufficient space above removable ceiling panels to allow for panel removal.
10. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals.
11. Provide for pipe expansion and seismic braces as required by the contract documents and/or jurisdictional authority.

12. All copper tube and fitting shall be reamed and buffed prior to soldering or brazing.
13. The use of solder containing lead is prohibited.
14. Refer and conform to the "Copper Development Association" instructions for proper preparation and actual installation practice for all soldered and brazed joints.
15. Provide 10 mil PVC tape (Scotchwrap No. 50 or equal) for all piping and fittings that are enclosed in concrete or masonry walls.

B. Domestic Water Service: Water service shall be laid at least 1'-0" below frost line.

C. Sanitary Waste and Vent Piping and Storm Drainage Piping:

1. Install building drain and storm sewer with not less than 3'-0" below frost level of earth cover below the finished grade.
2. Make changes in direction for drainage piping using appropriate 45-degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back-to-back and have a common drain.
3. Cast Iron Soil Pipe: Make compression joints and hubless joints in accordance with the recommendations in the CISPI Cast Iron Soil Pipe and Fittings Handbook, Chapter IV.
4. Underground PVC Pipe: Install in accordance with ASTM D 2321Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
5. Hubless cast iron pipe couplings shall be torqued per manufacturer recommendations.
6. Terminate all vents at 12" (minimum) above roof or snow level with vent caps.
7. Minimum roof drainage slope is 1/8 inch per foot.

D. Backflow Preventer:

1. Locate the valve where it will be visible and accessible for maintenance and at such location that dripping or discharge of water from relief vent will not create a nuisance or damage to finished surfaces.
2. Provide funnel assembly with backflow preventer. Hang and anchor funnel and drain piping rigid to the drain receptor.
3. Install a shutoff valve and strainer upstream and a shutoff valve downstream of the backflow preventer.
4. Provide suitable anchoring device for backflow preventer.

E. Water Pressure Regulator:

1. Provide a water pressure regulator where shown on the drawings.
2. Provide a bronze body wye strainer upstream and full port ball valves and unions upstream and downstream of each regulating valve.
3. Provide a pressure gauge with a gauge cock downstream of each regulating valve. Gauge range at building regulating valves shall be 0 to 200 psig.

F. Shock Absorber: Provide shock absorbers at all solenoid valves, quick-closing valves, and at each plumbing fixture or battery of plumbing fixtures on both hot and cold water supply branches. Size and locations shall be as per manufacturer's recommendations.

G. Freeze-proof Wall Hydrant:

1. Locate wall hydrants such that valve seat is exposed in warm space or warm intersecting wall.
2. Do not try to conceal wall hydrant in exterior wall.

H. Water Meter: Install water meter as required by the local authorities.

I. Floor Drains:

1. Set floor drains with the appropriate amount of recess so that the top will be lower than the surrounding floor. Recheck the floor drain setting during concrete finishing phase and adjust the strainer to the proper height.
2. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
3. Position drains so they are accessible and easy to maintain.
4. Provide waterless trap protection unless otherwise indicated.

J. Cleanouts:

1. Provide cleanouts in locations required by Code and at locations shown on the drawings. Full size for pipe up to 4 inches at the base of all vertical stacks, ends of sewer mains, changes in direction of sewer mains, and in horizontal runs of piping not over 50 feet apart for interior sewers, and not over 100 feet apart for exterior sewers. Install cleanouts so they are accessible by extending them through walls or floors. Install floor and wall cleanout covers for concealed piping.
2. For exterior cleanouts, extend cast iron inspection pipe up to exterior cleanout poured in place in 24" x 24" x 8" concrete block set flush with finished grade.

K. Flashing:

1. Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.
2. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer’s instructions.

L. Roof and Overflow Drain Installation:

1. Consult with the roofing applicator and set roof drains at the exact elevation required for proper drainage.
2. Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
3. Position roof drains so that they are accessible and easy to maintain.

3.3 FIELD QUALITY CONTROL

A. General Testing Procedures:

1. All piping systems shall be tested and proven tight prior to concealment. The test shall be witnessed by the Contracting Officer.
2. Isolate fixtures to prevent damage from pressure tests.

B. Domestic Water Pipe Testing:

1. Open and close all system valves at least once while system is pressurized to test valve packing. Tighten as required.
2. Test procedures shall be as follows:

    a. Domestic Hot and Cold Water: 150 psig hydrostatic test.
    b. All hydrostatic tests shall be held for a minimum of eight hours without loss of pressure.

C. Drainage Systems Testing Procedure: Drainage systems (including sanitary sewers, sanitary vents, and storm sewers): Test piping systems in accordance with the test procedures required by the applicable Plumbing Code.

D. Perform the following tests and prepare test reports:

1. Test each backflow preventer according to the device's reference standard. Obtain test certification from State testing official.

E. Adjust tempering controllers, to set point and prepare test report.

3.4 CLEANING

A. Sterilization:

1. Prior to placing the potable water system in operation, but after all testing has been completed, sterilize and flush the entire or sectionalized piping system per code. During this period of time, a pressure of not less than 40 psig shall be maintained on the section being opened and closed several times.
2. Water samples shall be taken and tested by an independent laboratory. The system must be free of all bacteriological contamination. If the system shows any contamination, it shall be re-chlorinated until it is free of bacteriological contamination.

END OF SECTION 221000

SECTION 223000
PLUMBING FIXTURES EQUIPMENT SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data:

1. Provide submittals on all items furnished under this section.
2. For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. For equipment and tanks required to be ASME rated and stamped; submit product data indicating compliance with the ASME pressure vessel requirements.

B. Shop Drawings:

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

C. Operating and Maintenance Manual: Submit operating and maintenance data and parts list for each item of equipment, control and accessory; including "troubleshooting" maintenance guide.

D. Field Quality Control Reports: Submit all test reports specified herein.

E. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency and marked for intended use.

C. Regulatory Requirements:

1. Comply with requirements in Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
2. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1,
3. ASME Compliance:

    a. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
    b. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

4. NSF Standard: Pipe, pipe fittings, joints, valves, faucets, and fixture fittings utilized to supply water for drinking or cooking purposes shall comply with NSF 372 and shall have a weighted average lead content of 0.25% or less.

D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

E. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Vitreous-China Fixtures: ASME A112.19.2M.
2. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
3. Water-Closet, Flushometer Tank Trim: ASSE 1037.

F. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 372.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.

G. Comply with the following applicable standards and other requirements specified for bathtub bathtub/shower and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

H. Comply with the following applicable standards and other requirements specified for miscellaneous fixtures and fittings:

1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Electric Water Coolers: ARI 1010.
4. Flexible Water Connectors: ASME A112.18.6.
5. Floor Drains: ASME A112.6.3.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Shower Receptors: ANSI Z124.2.
10. Plastic Toilet Seats: ANSI Z124.5.
11. Supply and Drain Protective Shielding Guards: ICC A117.1.

I. Certifications:

1. Gas water heaters shall be AGA certified.

1.4 COORDINATION

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

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion:

a. The gas-fired water heater (atmospheric burner) shall have a 5-year warranty.

PART 2 - PRODUCTS

2.1 FIXTURE TRIM

A. Lavatory Faucets:

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

a. American Standard Companies, Inc.
b. Chicago Faucet
c. Delta
d. Moen
e. Zurn

2. Description: Style as scheduled on drawings. Individual handles to include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Furnish with ASSE 1070 tempering valve where required by code.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.

B. Shower Faucets:

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

a. Lawler
b. Leonard Valve Company
c. Moen, Inc.
d. Powers; a Watts Industries Co.
e. Symmons Industries, Inc.
f. Zurn Plumbing Products Group; AquaSpec Commercial Faucet Operation.

2. Description: Single-handle thermostatic and pressure-balance valve, ASSE 1016. Include hot- and cold-water indicators; check stops; and shower head, arm, slide bar, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.

a. Body Material: Solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 1.5 gal or as otherwise scheduled.
d. Mounting: Concealed.
e. Backflow Protection Device for Hand-Held Shower:
f. Anti-scald Device: Integral with mixing valve.
g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

C. Sink Faucets:

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

a. American Standard Companies, Inc.
b. Chicago Faucet
c. Delta
d. Moen
e. Zurn

2. Description: Style as scheduled on drawings. Individual handles to include hot and cold water indicators. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.2 gpm or as otherwise scheduled.
d. Backflow Protection Device for Side Spray.

D. Flushometers:

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

a. Delany Co.
b. Hydrotek
c. Sloan Valve Company
d. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Style as scheduled on drawings. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
3. Match consumption to fixture requirement.

E. Toilet Seats:

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

a. Bemis Manufacturing Company
b. Church Seats
c. Olsonite Corp.
d. Sperzel
e. Zurn

2. Description: Toilet seat for water-closet-type fixture.

a. Material: Molded, solid plastic with antimicrobial agent
b. Configuration: Open front without cover
c. Size: Elongated
d. Hinge Type: Check
e. Class: Commercial
f. Color: White

F. Traps, Stops, Supplies, Drains:

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

a. American Standard
b. Brasscraft
c. Kohler
d. Zurn

G. Provide trim, supply, and waste connections for plumbing fixtures as scheduled on the drawings or as additionally required for a complete and operational fixture..

H. All exposed trim shall be chrome-plated brass unless otherwise specified in schedule.

2.2 FIXTURE SUPPORTS

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

1. Josam Company
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a division of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation

B. Water-Closet Supports: Description: Combination carrier designed for mounting height of wall-mounting, water-closet-type fixture shown on drawings. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:

1. Description: Urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:

1. Description: Lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.3 DISPOSERS

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

1. In-Sink-Erator
2. KitchenAid

B. Description: Continuous-feed household food-waste disposer. Include a reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery or stainless steel grinder or shredder; an NPS 1-1/2 outlet; quick-mounting, stainless steel sink flange; anti-splash guard; and combination cover/stopper.

2.4 FIXTURES

A. Water Closets:

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

a. American Standard Companies, Inc.
b. Eljer
c. Kohler Co.
d. Zurn

2. Description: Style, mounting, and flush mechanism as scheduled on drawings. Vitreous china body.
3. Consumption: 1.28 gal or as otherwise scheduled.

B. Urinals:

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

a. American Standard Companies, Inc.
b. Eljer

c. Kohler Co.
d. Zurn

2. Description: Style, mounting, and flush mechanism as scheduled on drawings. Vitreous china body.
3. Consumption: 0.125 gal or as otherwise scheduled.

C. Lavatories:

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

a. American Standard Companies, Inc.
b. Eljer
c. Kohler Co.
d. Zurn

2. Description: Style and mounting as scheduled on drawings. Vitreous china body.

D. Sinks, Stainless Steel:

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

a. Bradley Corporation
b. Elkay Manufacturing Co.
c. Just Manufacturing Company

2. Description: Style and mounting as scheduled on drawings.

E. Service Basins:

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

a. Crane Plumbing, L.L.C./Fiat Products
b. Florestone Products Co., Inc.

2. Description: Flush-to-wall, floor-mounting, precast terrazzo fixture with rim guard.

F. Electric Water Coolers:

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

a. Acorn Engineering Co.
b. Bradley Corporation
c. Elkay Manufacturing Co.

d. Halsey Taylor
e. Haws
f. Oasis

2. Description: Style and mounting as specified on drawings. Stainless steel, furnish with carrier. NSF-372 and UL listed.
3. Provide lead and chlorine filter with pre-strainer to limit lead content to 0.010 mg/L, remove 90% of free available chlorine, and remove 90% of particles 1.0 microns and larger.

2.5 POWER BURNER GAS-FIRED WATER HEATER

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

1. A. O. Smith
2. Aerco
3. Lochinvar
4. PVI
5. RECO
6. State

B. Provide the following:

1. The water heater shall be gas-fired with automatic controls including 100% shutoff in case of loss of pilot and/or too high of water temperature. The design shall be certified by A.G.A. The water heater shall meet ASHRAE 90.1-2019.
2. The power gas burner shall have electronic flame safeguard control and will be UL-listed. Heat exchanger shall be copper, secured into bronze. The entire assembled heat exchanger shall be approved and stamped for 160 psi (1,100 kPa) ASME operation. The gas burner will meet specifications required by UL.
3. Controls shall consist of upper and lower operating thermostats, temperature limiting device, draft regulator, thermometer, pressure gauges, and low-water cutoff.
4. The storage capacity and recovery capacity shall be as shown on the drawings.
5. Tank shall be heavy gauge steel, constructed in accordance with Section IV of the ASME code, and stamped for 125 psig working pressure with an inner lining of glass. There shall be insulation completely around the tank except the bottom. There shall be a hose thread drain valve at bottom of tank and a handhole cleanout.
6. Water heater shall have magnesium anode rod suspended in tank to minimize internal tank corrosion.
7. The water heater shall have a jacket of cold-rolled steel with baked-on enamel finish. Jacket shall have provisions for access to all controls and burners.
8. Provide temperature/pressure relief valve with AGA temperature steam rating in excess of the input rating of the water heater.

2.6 WATER HEATER ACCESSORIES

A. Piping-Type Heat Traps: Field Fabricated piping arrangement according to ASHRAE 90.1-2019.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Plumbing Fixtures and Trim:

1. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
2. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
    a. Use carrier supports with waste fitting and seal for back-outlet fixtures.
    b. Use carrier supports without waste fitting for fixtures with tubular waste piping.
    c. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
3. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
4. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
5. Install wall-mounting fixtures with tubular waste piping attached to supports.
6. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
7. Install counter-mounting fixtures in and attached to casework.
8. Install fixtures level and plumb according to roughing-in drawings.
9. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

a. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division22 Section "General Duty Valves for Plumbing Piping."

10. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
11. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
12. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
13. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
14. Install toilet seats on water closets.
15. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
16. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
17. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
18. Install shower flow-control fittings with specified maximum flow rates in shower arms.
19. Install traps on fixture outlets.
    Exception: Omit trap on fixtures with integral traps.
    Exception: Omit trap on indirect wastes, unless otherwise indicated.
20. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
21. Install dishwasher air-gap fitting on dishwasher standpipe.
22. Install chrome-plated escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing"
23. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07.
24. Provide chrome-plated anchor bolts and washers for all lavatories and china bolt caps for all floor-mounted water closets.

B. Water Heaters:

1. Free Standing Water Heaters.

a. Install domestic-water heaters on directly on the floor.
b. Maintain manufacturer's recommended clearances.
c. Arrange units so controls and devices that require servicing are accessible.

d. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
e. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
f. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
g. Install anchor bolts to elevations required for proper attachment to supported equipment.
h. Anchor domestic-water heaters to substrate.

2. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
3. Gas Water Heaters:

   a. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 Section "General Duty Valves for Plumbing Piping."
   b. Install gas-fired, domestic-water heaters according to the International Fuel Gas Code.
   c. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
   d. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in other sections of Division 23.

4. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
5. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.
6. Install thermometer on outlet piping of domestic-water heaters.
7. Provide isolation valves and dielectric couplings.
8. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
9. Fill domestic-water heaters with water.
10. Charge domestic-water compression tanks with air to domestic water static pressure.

3.3 CONNECTIONS

A. Water and gas piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Connections to individual fixtures shall not be less than sizes scheduled on the drawings unless otherwise specifically noted.

D. Provide rigid bracing for all stub-outs.

E. Ground equipment according to Division 26.

F. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Plumbing Fixtures and Trim

1. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
2. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
3. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
4. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
5. Confirm correct connection of hot and cold water supplies to fixtures.
6. Install fresh batteries in sensor-operated mechanisms.
7. Water closet fixtures not producing uniform rim flush and urinals not producing uniform wall flush shall be replaced.
8. Prepare test and inspection reports.

B. Water Heaters

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.
3. Remove labels.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by the Government.

3.8 DEMONSTRATION

A. Train the Government's maintenance personnel to adjust, operate, and maintain domestic-water heaters.

END OF SECTION 223000

SECTION 230500
COMMON WORKS FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All electrical work installed under Division 23 shall be in compliance with Division 26.

1.2 DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic in character indicating design concept and do not indicate every required duct or piping offset, valve, fitting, etc.

B. All drawings relating to this structure, together with these specifications, shall be considered in construction. The drawings and specifications are complementary, and what is called for in either of these shall be as binding as though called for by both. Should any conflict or omissions arise between the drawings and specifications, such conflict shall be brought to the attention of the Contracting Officer for resolution.

C. Unless otherwise indicated, all equipment and performance data listed is for job site conditions (elevation 6775 feet).

D. Drawings are not to be scaled.

1.3 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic
2. PE: Polyethylene plastic
3. PVC: Polyvinyl chloride plastic

G. The following are industry abbreviations for rubber materials:

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

1.4 SUBMITTALS

A. Division 23 Submittal Data and Shop Drawings:

1. Refer to Division 01, for general submittal requirements.

B. Schedules:

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

C. Close-out Submittals:

1. Operating and Maintenance (O&M) Manual:

a. Provide O&M manuals in accordance with Division 01.

D. Product Data:

1. Transition fittings
2. Dielectric fittings
3. Mechanical sleeve seals
4. Escutcheons
5. Motor Submittal Data: The following data shall be submitted for all motors:

a. Full load current and service factor running current at operating voltage.
b. Locked rotor current, starting power factor, and power factor at full load.
c. Efficiency at full load.
d. Data to substantiate Class F insulation with Class B rise at 100% load.
e. Full load speeds (rpm).
f. Enclosure type (ODP, TEFC, explosion proof, TENV, WPI, etc.)

Note: All tests (except locked rotor current) shall be made at full voltage and rated frequency.

6. Motor Controllers:

a. Torque, speed, and horsepower requirements of the load.

b. Ratings and characteristics of supply circuit and required control sequence.
c. Ambient and environmental conditions of installation location.

7. Capacitor size (KVAR) for maximum power factor correction at 95% lagging.
8. Identification: Submit product for each type of identification.

E. Certification:

1. Welding certificates

1.5 QUALITY ASSURANCE

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

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

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

C. Electrical Characteristics for HVAC Equipment: Equipment of lower or higher electrical characteristics may be furnished provided such proposed equipment variations are specifically identified as a deviation from contract documents and approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at no additional cost to the Government. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

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

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

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

D. Identification:

1. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
2. Coordinate installation of identifying devices with locations of access panels and doors.
3. Install identifying devices before installing acoustical ceilings and similar concealment.

E. Coordinate with all trades to maintain clearances to access panels, equipment, control and electrical panels. Intrusions into access space shall be brought to the attention of other trades. Notify Engineer of conflicts shown on drawings prior to installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles throughout Divisions 22, and 23 where subparagraph titles introduce lists of manufacturers, the following requirements apply for product selection:

1. Subject to compliance with requirements, provide products by one of the manufacturers listed.
2. Manufacturers other than the ones listed may be proposed under the provisions for Substitutions in Division 01.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 HVAC piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.3 JOINING MATERIALS

A. Refer to individual Division 23 HVAC piping Sections for special joining materials not listed below.

B. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

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

D. Solvent Cements for Joining Plastic Piping:

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

a. CPVC solvent cement used on any portion of below grade pipe extending into building envelope shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive primer used on any portion of below grade pipe extending into building envelope shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
c. Solvent cement and adhesive primer used on any portion of below grade pipe extending into building envelope 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 Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

a. PVC solvent cement used on any portion of below grade pipe extending into building envelope shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive primer used on any portion of below grade pipe extending into building envelope shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
c. Solvent cement and adhesive primer used on any portion of below grade pipe extending into building envelope 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 TRANSITION FITTINGS

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

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson

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

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

1. Available Manufacturer: Eslon Thermoplastics

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

1. Available Manufacturer: Thompson Plastics

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

1. Available Manufacturers:

a. NIBCO Inc.
b. NIBCO, Inc.; Chemtrol Division

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

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Co.
d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

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

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

C. Dielectric Unions: Use dielectric couplings.

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

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Co.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Division

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

1. Available Manufacturers:

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

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

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

1. Available Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

2.6 MECHANICAL SLEEVE SEALS

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

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. PSI/Thunderline/Link-Seal

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Zinc dichloromate or glass reinforced plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

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

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

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

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

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

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

1. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass.

a. Finish: Polished chrome-plated.

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

a. Finish: Polished chrome plated.

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

a. Finish: Polished chrome plated.

4. One-Piece, Floor-Plate Type: Cast-iron floor plate.
5. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.

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

2.10 ELECTRIC MOTORS

A. General: All motors (except as noted) shall conform to the following specifications:

1. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or sections.
2. Comply with NEMA MG 1 unless otherwise indicated.
3. Motors shall be UL listed for intended use.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40°C and at site elevation.
2. 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.
3. Motor Selection Criteria:

    a. Motor sizes shall be large enough so that the driven load will not require the motor to operate above 80% of its rated horsepower. Minimum horsepower ratings are shown or scheduled on the drawings.
    b. Pump motors shall be "non-overloading"; i.e. shall not operate in service factor at any point on pump curve.

C. Single Phase Motors:

1. Motors shall be in compliance with DOE Energy Conservation Standards for Small Electric Motors
2. Motors shall be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor (PSC).
    b. Split phase.

3. Multispeed Motors:

    a. Electronically commutated motor (ECM): Provide ECM motors with speed control when available as an option.
    b. Variable-torque, permanent-split-capacitor type.

4. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
5. 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.

D. Electrically Commutated Motors

1. Motor shall be electronic commutation (EC) type specifically designed for application.
2. Motors shall be permanently lubricated with heavy duty ball bearings to match the driven load.
3. Motor speed shall be speed controllable down to 20% of full speed (80% turndown.)M
4. Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal. Both capabilities shall be provided.

2.11 MOTOR CONTROLLERS

A. General Motor Controller Characteristics:

1. Single speed and multi-speed motor controllers shall be combination type, full NEMA-rated starters with motor circuit protector for all motors provided.
Exception: Starters that are shown to be provided integral within packaged equipment, control panels with door mounted disconnects or in motor control centers.
2. All combination starters shall be adequately braced for the fault current available. 14,000 AIC @ 208V, 1-phase shall be the minimum ratings.
3. All starters, whether separately furnished or integral with equipment, shall comply with the following:

a. Enclosures: NEMA Type 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA Type 4 with conduit hubs, or units in hazardous locations that shall have NEC proper class and division explosion-proof enclosure.

b. Single-phase Starters: Starters shall be shall be horsepower-rated thermal overload switches.

2.12 MISCELLANEOUS ELECTRICAL DEVICES

A. Furnish all necessary control devices such as speed controls, transformers, and relays as required for proper operation of all equipment furnished under this Division.

B. Enclosures: NEMA Type 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA Type 4 with conduit hubs, or units in hazardous locations that shall have NEC proper class and division explosion proof enclosure.

2.13 ACCESS PANELS OTHER THAN SHEET METAL

A. Refer to Division 08 for specification of access doors.

B. Access panels are to have Underwriters' Laboratories B label fire rating when installed in fire-rated walls or ceiling.

C. Access panels for installation in plaster are to be similar to Milcor style "K," all other access panels are to be similar to Milcor style "M."

D. Panels located in public areas are to have keyed locks.

2.14 IDENTIFICATION

A. Equipment Labels:

1. Metal Labels for Equipment:

2. Plastic Labels for Equipment:

    a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
    b. Letter Color: White.
    c. Background Color: Black or blue.
    d. Maximum Temperature: Able to withstand temperatures up to 160°F.
    e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 x 3/4 inch.
    f. 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-fourths the size of principal lettering.
    g. Fasteners: Stainless steel rivets or self-tapping screws.
    h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

3. Label Content: Include equipment's unique equipment number.

B. Pipe Labels:

1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
2. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
3. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
4. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

    a. 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.
    b. Lettering Size: At least 1-1/2 inches high.

C. Duct Labels:

1. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160°F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 4 x 12 inch.
6. Minimum Letter Size: 2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

8. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.

    a. 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.
    b. Arrow Size: At least 6 inches high.

PART 3 – EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying HVAC piping systems.

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

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

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

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

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

    1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: Split, cast-brass type with spring clips.
d. Bare Piping at Wall, Floor, and Ceiling Penetrations in Finished Spaces, Unfinished Service Spaces, and Equipment Rooms: One-piece or split, cast-brass type with polished chrome-plated finish.

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

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

1. Cut sleeves to length for mounting flush with both surfaces.
Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inchannular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials, seismic installation may require additional clearance:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions. Seal space outside of sleeve fittings with grout.

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

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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

P. Verify final equipment locations for roughing-in.

Q. Refer to equipment specifications in other sections of these specifications for roughing-in requirements.

R. Install dielectric fittings or approved adaptor fittings on all joints between different piping materials on steam, hot water, chilled water, condenser water, steam condensate, ground source heat pump loop systems and other hydronic mechanical piping systems.

S. Excavation, Bedding, and Backfill:

1. Provide all excavation, bedding, and backfill required in connection with the work under this Division.
2. Include provisions for repairing of finished surfaces, all required shoring, bracing, pumping, and protection for safety of persons and property.
3. All excavation, bedding, backfill, and compaction shall be in conformance with Division 31 of these specifications. Backfill shall not be done until pipe lines are properly tested in the presence of the Authority Having Jurisdiction where required.

T. Old Pipe Lines: If any old sewer, water, gas, or other pipes are encountered that interfere with the proper installation of new work and that will not be used in connections with the new work, close all openings in proper manner or, if necessary, relocate or remove the pipes as shown on plans. Should any old pipes and/or electrical lines not shown on plans be encountered, immediately notify Government's representative before taking any action.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

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

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

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

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

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

H. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D2846 Appendix.

I. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

3.3 ACCESS PANELS

A. Furnish access panels where required for access to concealed HVAC items such as dampers, valves, strainers, shock absorbers, cleanouts, control devices, and where required for equipment servicing.

B. Deliver all panels to General Contractor for installation. Provide instructions for their location in sufficient time so panels can be installed in the normal course of work.

3.4 IDENTIFICATION COMMON REQUIREMENTS

A. Preparation: 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.

B. Equipment Label Installation:

1. Install or permanently fasten labels on each major item of HVAC equipment.
2. Locate equipment labels where accessible and visible.

C. Pipe Label Installation:

1. 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:

    a. Near each valve and control device.
    b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
    c. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
    d. At access doors, manholes, and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.
    f. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
    g. Piping colors shall be per ANSI A13.1

D. Duct Label Installation:

1. Install plastic-laminated self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

   a. Black on white on HVAC ducts
   b. ASME A13.1 Colors and Designs for hazardous material exhaust

2. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 for structural steel and Division 23 Section "Wind, and Vibration Controls for HVAC" for additional requirements.

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

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

3.6 CLEANING

A. Cleaning and Flushing:

1. All water circulating systems for the project shall be thoroughly cleaned before placing in operation to rid the system of dirt, piping compound, mill scale, oil, and any and all other material foreign to the water being circulated.
2. Extreme care shall be exercised during construction to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped, and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and all dirt removed.
3. After the system (or portion thereof) has been leak tested, thoroughly flush with clean water. During the clean water flush, all valves shall be full open, the flow rate for flush shall be at least 4 ft./sec., and the total flow shall equal at least five times the total piping system volume. Flushing shall continue until water runs clear.
4. After clear water flushing is complete, a chemical flushing solution, shall be utilized to remove oil, grease, piping compounds, etc. After the system is filled with this solution, the system shall be brought up to temperature and allowed to circulate for at least eight hours. The system shall then be drained completely and reflushed with fresh water.
5. After the system has been completely cleaned as specified herein, it shall be tested by litmus paper or other dependable method and shall be left on the slightly alkaline side (pH = 7.5+). If the system is found to be still on the acid side, the chemical flush shall be repeated as necessary.

6. The Government's representative shall be given notice of this cleaning operation. If the Government's representative deems it necessary, the cleaning operation shall be repeated.
7. "Stop-Leak" compounds shall not be added to the system at any time.
8. Clean exterior of piping prior to application of coatings.

B. Cleanup:

1. Clean coils and plenums.
2. Clean under, in and around equipment.
3. Clean exposed surfaces of ducts, piping, and equipment.
4. Clean equipment cabinets and enclosures.
5. Provide all new filters for equipment.

END OF SECTION 230500

This page intentionally left blank.

SECTION 230525
VARIABLE FREQUENCY DEVICES FOR HVAC SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. IGBT: Insulated gate bipolar transistor

B. LAN: Local area network

C. PID: Control action, proportional plus integral plus derivative

D. PWM: Pulse-width modulated

E. VFD: Variable frequency drive

1.3 SUBMITTALS

A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details
b. Nameplate legends
c Short-circuit current rating of integrated unit

C. Wiring Diagrams:

1. Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.
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. Network information, point addresses, etc.

D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Qualification Data: For manufacturer and testing agency.

F. Field quality-control test reports.

G. Certificates: Unit shall be UL or ETL Testing Laboratory listed.

H. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include routine maintenance requirements for VFDs and all installed components.

I. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. VFDs and options shall be UL508 listed as a complete assembly.

C. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather (allowed only when factory installed in equipment), cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40°C (32°F to 104°F).
2. Humidity: Less than 90% (noncondensing).
3. Altitude: 6,775 feet above sea level, derate as required for project altitude.

1.7 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases for floor mounted equipment. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate installation of disconnects on load side of VFD with electrical contractor. Do not operate VFD without load side disconnect interlocked to VFD control power.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

1.9 EXTRA MATERIALS

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

1. Power Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary
2. Danfoss North America
3. Eaton Corporation; Cutler-Hammer Products
4. Hitachi America, Ltd.
5. Mitsubishi Electric Automation Inc.
6. Rockwell Automation; Reliance Electric
7. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group
8. Toshiba International Corporation
9. Yaskawa Electric America

2.2 VARIABLE FREQUENCY DRIVES

A. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

B. Application: Variable torque.

C. VFD Description:

1. Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more 3-phase induction motors by adjusting output voltage and frequency.
2. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Drive control shall have an automatically variable carrier frequency of at least 1,000 to 12,000 Hz. There shall be no sudden frequency shifts that cause acoustical noise increases during shifts in the motor speed.

F. Output Rating: 3-phase; 6 to 66 Hz, with voltage proportional to frequency throughout voltage range.

G. Unit Operating Requirements:

1. Input ac voltage tolerance, plus or minus 10%.
2. Input AC Voltage Unbalance: Not exceeding 3%.
3. Input frequency tolerance of 60 Hz, plus or minus 3%.
4. Minimum Efficiency: 97% at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98%.
6. Overload Capability: 1.1 times the base load current for 60 seconds; 1.8 times the base load current for 3 seconds.
7. Starting Torque: 100% of rated torque or as indicated.
8. Speed Regulation: Plus or minus 1%.
9. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
10. Ambient Temperature Rating: Not less than 32°F and not exceeding 104°F.
11. Ambient Storage Temperature Rating: Not less than minus 4°F and not exceeding 140°F.
12. Humidity Rating: Less than 95% (noncondensing).
13. Altitude Rating: Derated for site elevation.

H. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25% of maximum rpm
2. Maximum Speed: 80 to 110% of maximum rpm
3. Acceleration: 2 to a minimum of 22 seconds
4. Deceleration: 2 to a minimum of 22 seconds
5. Current Limit: 50 to a minimum of 110% of maximum rating
6. Operating Frequency Lockout: 3 frequency bands

J. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide 3-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Over temperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD over temperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor over temperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Disconnecting Means and Overcurent Protection Device: NEMA KS 1, fusible switch with pad lockable, door-mounted handle to protect VFD circuit and bypass circuit.

1. Disconnect Rating without by-pass: Not less than 115% of VFD input current rating.
2. Disconnect Rating with by-pass: Not less than 115% of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.

2.3 CONTROLS AND INDICATION

A. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed backlit keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

3. Display shall indicate the following controller parameters:

a. Output frequency (Hz)
b. Motor speed (rpm)
c. Motor status (running, stop, fault)
d. Motor current (amperes)
e. Motor torque (percent)
f. Fault or alarming status
g. PID feedback signal (percent)
h. DC-link voltage (V dc
i. Set-point frequency (Hz)
j. Motor output voltage (V ac)

B. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

C. Control Signal Interface:

1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: (0 to 10V or 0-20 mA or 4-20 mA).
b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the control systems:

a. 0 to 10V dc

b. 0-20 mA or 4-20 mA
c. Potentiometer using up/down digital inputs
d. Fixed frequencies using digital inputs

3. Output Signal Interface: A minimum of 1 analog output signal (0-20 or 4-20 mA) that can be programmed to any of the following:

a. Output frequency (Hz)
b. Output current (load)
c. DC-link voltage (V dc)
d. Motor torque (percent)
e. Motor speed (rpm)
f. Set point frequency (Hz)

4. Remote Indication Interface: A minimum of two programmable dry circuit relay outputs (120V ac, 1A) for remote indication of the following:

a. Motor running
b. Set-point speed reached
c. Fault and warning indication (overtemperature or overcurrent)
d. PID high- or low-speed limits reached

D. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

2.6 ENCLOSURES

A. VFD Enclosures: NEMA 250 completely assembled and tested by the manufacturer in an ISO9001 facility, to comply with environmental conditions at installed location:

1. UL Type 1 (NEMA 1): suitable for most commercial interior locations
2. UL Type 3R (NEMA 3R): protection against falling rain and undamaged with the formation of ice on the enclosure

2.7 FACTORY FINISHES

A. Finish: Manufacturer's standard finish applied to factory-assembled VFDs.

2.8 REQUIRED OPTIONS

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

3.2 APPLICATION

A. Provide VFDs where scheduled on drawings.

3.3 INSTALLATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26.

C. The drives shall be installed, wired, tested, and calibrated per the manufacturer's recommendations.

D. Comply with mounting and anchoring requirements specified in Division 23Section "Hangers and Supports for HVAC Systems" and Division 23Section "Wind, and Vibration Controls for HVAC."

E. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26."

F. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26.

G. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring according to Division 23Section "Common Requirements for HVAC Systems."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect drives, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state drives and participate in the commissioning process.
3. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
2. Test continuity of each circuit.
3. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Solid-state components shall be load-tested to ensure correct function and highest reliability. Provide “signed off” checklist.
6. Every controller will be functionally tested under designed motor load for at least two hours with written certification to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
8. Network Controls: Verify communications wiring and test bi-directional communications of all specified point data.

D. VFDs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain variable frequency drives. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230525

This page intentionally left blank.

SECTION 230529
HANGERS AND SUPPORTS FOR MECHANICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

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

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

1.3 PERFORMANCE REQUIREMENTS

A. Hangers and supports for MECHANICAL piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE.

1. Supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: Provide sufficient information to show the hangars and supports are suitable for the intended purpose, including design loads and actual loads. Provide submittal data for:

1. Mechanical systems and equipment hangers and supports
2. Thermal-hanger shield inserts
3. Devices for attachment to the structure
4. Powder-actuated fastener systems
5. Recognized, catalogued, pre-engineered hangar and support systems.

B. Wind Resistance Data: For all systems and equipment installed outdoors, submit shop drawings indicating the design of the supports and curbs, the attachments to supports and curbs, and the attachment of the support and curbs to the structure, slab, or grade as required to provide resistance to the wind forces identified in specification section 23 0548 “Wind, Seismic, and Vibration Controls”. Where there is no product of this section installed outdoors, no such submittal is required.

C. Shop Drawings: Provide fabrication and installation details, calculations; signed and sealed by a qualified professional engineer, and Product Data for the following systems:

1. Trapeze pipe and duct hangers, multi-trade support racks, and equipment supports not addressed by recognized, catalogued, pre-engineered methods.
2. Contracting Officer Responsibilities: The Contracting Officer shall review delegated design submittals for compliance with specification requirements. Design and analysis performed by the Engineer-in-Responsible Charge of the delegated design submittal will not be reviewed.

D. Welding Certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers:

1. Anvil International
2. B-Line Systems, Inc.; a division of Cooper Industries
3. Carpenter & Paterson, Inc.
4. ERICO/Michigan Hanger Co.; ERISTRUT Div.
5. GS Metals Corp.
6. National Pipe Hanger Corporation

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

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

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

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

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

2.5 FASTENER SYSTEMS

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

1. Manufacturers:

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

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

1. Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head
c. Masterset Fastening Systems, Inc.
d. MKT Fastening, LLC
e. Powers Fasteners

2.6 PIPE STAND FABRICATION

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

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

1. Manufacturers:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries

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

1. Manufacturer: MIRO Industries

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

1. Manufacturers:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries
c. Portable Pipe Hangers

2. Bases: 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: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturer: Portable Pipe Hangers
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 support made from structural-steel shape, 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-steel shapes.

2.8 MISCELLANEOUS MATERIALS

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

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

1. Properties: Non-staining, non-corrosive, and non-gaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 – EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

B. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.

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

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

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-58 and MSS SP-89 for the installation of hangers, supports, clamps, and attachments to properly support piping from building structure.

B. Hanger Spacing:

1. Hanger spacing and sizing shall per MSS SP-58 or applicable codes, whichever is more stringent.
2. Hanger spacing must be reduced to compensate for any valves and/or fittings installed in the pipe run.
3. Alternate span calculations may be used with a maximum deflection of 0.1 inch between hangers.
4. Hanger spacing must be reduced if thermal hanger shield insert cannot support full span.

C. Channel Support or Steel Trapeze System Installation:

1. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

D. Hanger and Support Installation:

1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
2. Install hangers and supports to allow controlled thermal 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.
3. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
4. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31 is not exceeded.
5. Comply with the following for insulated piping:

    a. Attach clamps and spacers to piping.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Generator exhaust piping: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    d. Do not exceed pipe stress limits according to ASME B31.1.
    e. Provide protection shields at all pipe supports. Metal shield lengths shall be as required by MSS-SP58 for the compressive strength and support span. Manufactured units shall include certification of compliance with MSS-SP58 for intended use. Requirements shall be as follows:

        1) Insulated piping up to NPS 1-1/2 - MSS Type 40 insulation protection shields without high-density inserts.
        2) Insulated piping NPS 2 and larger - MSS Type 40 thermal-hanger shield assemblies with the high-density inserts having the same thickness as piping insulation.

E. Building Attachments:

1. Review structural drawings for details of methods of attachment. Coordinate support requirements with project structural engineer.
2. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length specified herein or as indicated in MSS SP 58. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
3. Install powder-actuated drive-pin fasteners 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.
4. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

5. Attachments to bar joists shall be at panel points and shall comply with load limits and other requirements of the Structural Engineer.

3.3 EQUIPMENT SUPPORTS

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

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

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

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

B. Fit exposed connections together to form hairline joints. Connections shall be welded.

3.5 ADJUSTING

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

3.6 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.

1. Non-flat paints and coatings used within buildings shall have a VOC content of 150 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Low-Emitting Materials: Interior paints and coatings 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. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.3.1.

1. Galvanizing repair paints and coatings used within buildings shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Low-Emitting Materials: Interior paints and coatings 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."

END OF SECTION 230529

SECTION 230548
WIND AND VIBRATION CONTROLS FOR MECHANICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

B. Work of this section shall be applied to all Division 22, and 23 specifications and drawings. Additional seismic criteria may be specified in individual sections.

1.2 SUMMARY

A. This project requires vibration and acoustic isolation of mechanical systems.

B This project requires all exterior mechanical systems and equipment to resist design wind forces.

C. The work in this section includes Delegated Design for the following:

1. Delegated design for wind resistance

1.3 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

A. Design Parameters:

1. Building Risk Category: II
2. Wind Design Criteria:

a. See Structural drawings.

B. General Wind Design and Performance Requirements:

1. Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressures determined in accordance with the International Building Code.
2. Where lateral and vertical uplift forces are identified on the structural drawings for exterior mounted equipment, piping, ductwork, and appurtenances, provide certification that all components will withstand those forces, and design all supports and attachments to resist those forces.
3. Where lateral and vertical uplift forces are not identified on the structural drawings for exterior mounted equipment, piping, ductwork, and appurtenances, determine those forces using the wind design criteria above using the methods of the International Building Code and ASCE-7, then provide certification that all components will withstand those forces, and design all supports and attachments to resist those forces.

1.4 SUBMITTALS

A. Product Data:

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of device used.

B. Shop Drawings:

1. Wind restraint shop drawings: Where manufactured, pre-engineered equipment or components indicating compliance with the wind resistance requirements is not available, submit shop drawings indicating support, anchorage, and attachment.

C. Delegated Design Submittal for Wind Restraint:

1. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and wind forces required to select wind restraints.
2. Design Analysis: To support selection and arrangement of wind and seismic restraints based on design wind related forces.
3. 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 wind events. Indicate association with vibration isolation devices.
4. Where catalogued and pre-engineered manufactured equipment, components, or restraint systems meet wind the forces determined through the design analysis, documentation from the manufacturer will be acceptable. Otherwise, analysis data and shop drawings shall be signed and sealed by the qualified licensed professional engineer responsible for their preparation.

PART 2 – PRODUCTS

PART 3 – EXECUTION

3.1 EXAMINATION

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

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

3.2 VIBRATION-CONTROL WIND -RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Install restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

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 as approved by structural engineer.

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 pre-stressed 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.

3.3 FIELD QUALITY CONTROL

A. Inspections:

1. Measure isolator restraint clearance.
2. Measure isolator deflection.

B. Adjusting:

1. Adjust isolators after piping system is at operating weight.
2. 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. Adjust active height of spring isolators.
4. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230548

This page intentionally left blank.

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 Specifications, apply to this Section.

1.2 SUBMITTALS

A. Samples: Submit proposed test and balance forms and report formats at least 120 days prior to commencing field work.

B. Quality Assurance/Control Submittals: Qualifications - Within 30 days after contract award, submit the name(s) of the professional engineer and/or the NEBB or AABC certified supervisor who will be supervising this work. Submit the name(s) of the test and balance technician(s) who will be performing the work.

C. Closeout Submittals:

1. Test and Balance Report: After all balancing is complete, and all coordination with the Commissioning Agent and the Contracting Officer is complete, the balancing firm shall furnish four bound reports that shall contain the test data information as detailed in Part 3 and as follows:

a. Results of dynamic balance testing:

1) All test values exceeding manufacturer's standards shall be identified with recommendations for corrective action.
2) Retest results for rejected devices after corrective action.

b. A reduced set of drawings (11" x 17") shall be included in the report with all terminals (air outlets, inlets, coils, heaters, etc.) clearly marked, all equipment designated, and all referenced to the device test reports. The contract drawings may be reduced and used for this purpose, if they remain legible.

c. The test and balance Contractor shall submit bound copies of the final testing and balancing report to the Contracting Officer at least 15 days prior to the Mechanical Contractor's request for final inspection. All data shall be recorded on applicable reporting forms. The report shall include all operating data as required in Part 3, a list of all equipment used in the testing and balancing work, and shall be signed by the supervising registered engineer or certified test and balance supervisor and certified test and balance technician, and affixed with his certification seal. Final acceptance of this project will not take place until a satisfactory report is received.

2. Balance report shall not be submitted until all improperly configured or installed systems are corrected and improperly installed or missing balance devices are corrected and tested reports submitted with incomplete information will be returned unreviewed.

1.3 QUALITY ASSURANCE

A Qualifications:

1. The balancing work, shall be performed by the same firm having total professional responsibility for the final testing, adjusting, and balancing of the entire system. The test and balance firm shall not be associated with the Commissioning Agent.
2. Test and balance firm shall:

    a. Have had previous experience with at least one project of similar type and size in the State of Colorado. Provide the project(s) name, Government, general contractor, mechanical contractor, and references with phone numbers for each.
    b. Have a permanent place of business and phone number within a 250-mile radius of the job site.
    c. Have been actively engaged in balancing work within the State of Colorado for at least three of the past five years. Provide at least three project references with phone numbers.
    d. Have a minimum of two permanent employees who have been actively engaged in balancing work for a minimum of 3 years. Provide names, certifications, and experience resumes.

3. The test and balance field work shall be performed under the direct supervision a NEBB or AABC certified test and balance supervisor. The certified supervisor shall:

    a. Perform the test and balance work or be on-site at least 33% of the total time the test and balance work is in progress, or
    b. Be on site a minimum of 10% of the total time the test and balance work is in progress with the work performed by a full-time certified NEBB or AABC test and balance technician.

B. Certifications:

1. Testing, adjusting, and balancing shall be done by a firm using NEBB or AABC certified supervisors, or by an independent firm specializing in this work. A definition of independent shall mean the firm is not associated with the contractor performing work under Division 23; the firm derives its income solely from testing, adjusting, and balancing and/or commissioning mechanical systems; and the work is performed in a professional manner.
2. Test and balance firm shall own or rent and have available for this project all necessary balancing instruments as required to maintain NEBB or AABC certification. Instrument calibration shall have been checked and verified as per NEBB AABC requirements. Provide instrument list with calibration date for each instrument listed.

C. Regulatory Requirements:

1. Refer to Division 23Section "Common Work Results for HVAC," for general code, standard and regulatory requirements.
2. Comply with procedural standards for testing, adjusting, and balancing of environmental systems as outlined in the latest edition of SMACNA, NEBB, and/or AABC procedural manuals.
3. ASHRAE Compliance:

    a. Applicable sections and paragraphs as published in ASHRAE 2011 Applications Handbook, Chapter 38, Testing, Adjusting, and Balancing, and Standard 111.
    b. Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

4. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007-, Section 6.7.2.3 - "System Balancing."

1.4 SCHEDULING

A. Coordinate scheduling of work with the General Contractor, the appropriate subcontractors.

1. Schedule test and balance work to coincide with testing and verification of control systems where practical.
2. Coordinate system startup and performance verification with the Commissioning Agent as test and balance work is in progress.

B. Provide written notification (within 24 hours) to General Contractor, Commissioning Agent, and Contracting Officer of any component and/or system deficiencies.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Provide all necessary tools, scaffolding, and ladders.

B. Provide all necessary instruments. Calibration and maintenance of instruments shall be in accordance with NEBB or AABC. Calibration histories for each instrument shall be available for examination.

C. Provide all sheaves necessary to obtain design airflow from fans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Air testing and balancing shall not begin until the system to be tested has been cleaned, and is in full working order.

B. Preliminary test and balance requirements shall be ascertained prior to the commencement of work through a review of available plans and specifications for the project. In addition, visual observations at the site during construction shall have been made to determine the location of required balancing devices; that they are being installed properly; and that proper access has been provided.

C. Prior to and during testing and balancing, the testing and balancing technician shall immediately notify the Contractor of all balancing devices not yet installed and those portions of the system unable to be balanced. The Contractor shall correct the deficiencies and shall notify the Engineer of situations requiring additional instruction.

D. Before any air balance work is done, the system shall be checked for:

1. Excessive duct, plenum, and equipment leakage
2. Dirt and debris in ducts and/or AHUs
3. Filters are installed (and changed if they are dirty)
4. Coil fins are clean and combed where needed
5. Correct motor rotation
6. Excessive vibration
7. Equipment lubrication
8. Proper operation of automatic control and smoke dampers
9. Manual control dampers, fire dampers, and air outlet dampers are wide open
10. Duct end caps installed and access doors closed
11. Grilles, registers, and diffusers are properly installed

E. Put heating, ventilating, and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing.

3.2 REQUIREMENTS OF WORK

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

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, install test ports and duct access doors that comply with requirements in Division 23 Section "Ducts and Accessories."
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "Mechanical Insulation."

C. Mark equipment and balancing devices, including damper-control positions, 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.

E. All equipment, provide the following included with the equipment test data. Underlined items require other equipment test data sections be included within specified test data section:

Electric Motor, Drive, VFD Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Motor			
Motor HP	X	X	
Motor type (ODP, TEFC, etc.)	X	X	
Motor RPM	X	X	X
Voltage per phase	X	X	X
Motor amperage per phase	X	X	X
Motor service factor	X	X	
Motor efficiency class (EPACT, NEMA Premium, etc.)	X	X	
Belt Drive			
Motor sheave OD (Belt Drive)		X	X
Fan sheave ID (Belt Drive)		X	X
Sheave centerline distance (Belt Drive)			
Number/size belts (Belt Drive)		X	X
Driven RPM Initial (Fan, etc.)			X
Driven RPM Final (Fan, etc.)			X
Motor Starter			
Manufacturer	X	X	
Model	X	X	
Size	X	X	
Overload size/ Electronic overload set point	X	X	
Trip class set point	X	X	
VFD			
Manufacturer	X	X	
Model	X	X	
Main fuse size	X	X	

Electric Motor, Drive, VFD Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
VFD fuse size	X	X	
Bypass fuse size (when equipped)	X	X	
Maximum frequency set point			X
Minimum frequency set point			X
Final frequency set point			X
Resonant/vibration frequency lock-out bands			X

F. Air Balance, provide the following:

Air Handling Unit Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Unit designation	X		
Manufacturer	X	X	
Model number	X	X	
Total supply airflow	X		X
Return airflow	X		X
Outside airflow (all modes); confirm accuracy of min OSA controller if installed	X		X
Total design outlet airflow	X		X
Total SP	X		X
External SP	X		X
Internal SP	X		
Static pressure across all elements			X
Fan discharge SP			X
Fan Suction SP			X
AHU discharge SP			X
AHU return SP			X
Supply air temperature**			X
Return air temperature**			X
Mixed air temperature**			X
Outside air temperature**			X
Mixed Air Temperature**			X
Include Motor, Drive, VFD Test Data*			

Air Handling Unit Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Include Coil Test Data			

** VFD may be used to balance belt drive fans +/- 10%.*

*** Provide when requested by Engineer.*

Fan Test Data (125 W or 1/6 hp and larger)			
Item*	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Unit designation	X		
Type of Service	X		
Manufacturer	X	X	
Model number	X	X	
Total airflow	X		X
External SP	X		X
Fan discharge SP			X
Fan Suction SP			X
Include Motor, Drive, VFD Test Data*			

**VFD may be used to balance fans +/- 10%.*

Fan Test Data (less than 125 W or 1/6 hp)			
Item*	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
System designation	X		
Outlet Number	X		
Manufacturer	X	X	
Total airflow	X		X

** Motor, Drive, VFD Test Data not required.*

Air Outlet Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Unit designation	X		

Air Outlet Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Type of service	X		
Area served	X		
Final velocity (when Ak ≠ 1.0)			X
Ak factor (when Ak ≠ 1.0)	X		
Final airflow			X
First test reading			X
Instrument used for testing			X
Duct Traverse Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
System designation	X		
Traverse designation	X		
Location	X		
Airflow	X		X
Duct size, I. D.	X		X
Duct area	X		X
Average velocity			X
Static pressure at traverse			X
Instrument used for testing			X
Duct Air Leakage Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
System designation	X		
Service	X		
Location/zone	X		
Altitude	X		
Density	X		
Leakage class	X		
Design static pressure	X		
Pressure class	X		
Seal class	X		
Airflow volume	X		
Surface area	X		

Air Outlet Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Airflow per surface area factor	X		
Percent allowable leakage	X		
Test static pressure			X
Test section air leakage			X
Test section percent air leakage			X
Test witnesses			X

G. Coil Balance, provide the following:

Electric Heating Coil Test Data			
Item	**Tabulate Design/Submittal Data**	**Confirm Actual Installation**	**Test**
Coil designation	X		
System served	X		
Coil location	X		
KW	X	X	
Voltages	X	X	X
Phase	X	X	
Amperages	X	X	X
Design airflow	X		
Design airside ΔP	X		
Initial airflow			X
Final airflow			X
Final airside ΔP			X
Entering dry bulb temperature	X		X
Leaving dry bulb temperature	X		X

H. Adjust air handling systems to the following tolerances:

1. Supply systems shall be balanced so that:

   a. The total quantity to each space is within -5% to +10% of design values.
   b. If two outlets in space, each outlet is within -10% to +10% of design value.
   c. If three or more outlets in space, each outlet is within -15% to +15% of design value.

2. Exhaust and return systems shall be balanced so the total quantity from each space is -10% to +10% of design values.
3. Air diffuser patterns shall be set to minimize objectionable drafts and noise.
4. The supply, return, and exhaust fan static pressure controls shall be set by the balancing firm (and the Controls Contractor if the systems have fan volume control).

    a. The pitot tube traverse method for determining main duct cfm shall be used and recorded wherever possible; flow hood measurements at registers and diffusers may be totalized for branch duct quantities.
    b. The supply air system shall be tested in all operating modes (full return air, full outside air, full cooling with the design diversity, and full cooling with no diversity).
    c. After balancing is completed, check fan motor amperage with the filters clean.
    d. System static pressure profiles and fan motor amperages shall be recorded in all modes.
    e. The lowest fan speed resulting in satisfactory system performance shall be determined at full design airflow. Any inlet or outlet fan volume (balancing) dampers shall be in the wide-open position and one path presenting the greatest resistance to flow shall be fully open and unobstructed.

5. Provide system static pressure profiles that identify pressure differences across all components of air handling units and built-up systems. Pressure drops shall be individually measured and recorded for intake and exhaust vents, hoods, louvers, manual and auto control dampers, filters, coils, evap. coolers, fans, terminal units, etc.

    a. On systems with OSA economizers, pressure drop values shall be recorded for both minimum and 100% OSA modes.

6. Building static pressure adjacent to entries shall be measured and recorded. Adjust systems to maintain a positive pressure of 0.05-inch w.c. when possible. Note any discrepancies.
7. Final adjustments shall include but not be limited to the following:

    a. Fans:

        1) Belt Drive: RPM - Include sheave and belt exchange as required to deliver airflow within limits of installed motor horsepower and mechanical stress limits of the fan. Determine the limiting fan tip speed before increasing rpm. Final fan speed setting shall allow for predicted filter loading and shall provide proper duct pressures for operation of zone terminal units where used.
        Note: Fan rpm shall not be increased more than 10% from the factory setting without prior authorization by the Engineer.
        2) VFD Drive: Coordinate VFD startup with the applicable Division 23 vendor. Adjust maximum and minimum rpm settings as necessary to obtain design cfm. Belt drives shall be adjusted to +/- 10% with VFDs used for

trimming. Verify that ramp-up and down adjustments are made as necessary to prevent overshoot and "hunting."

3) Direct Drive:

a) RPM with Speed Taps: Set fan speed on tap that most closely approaches design cfm. Report tap setting on equipment data sheet.
b) RPM with Speed Control Rheostat: Set output of fan to design cfm by adjusting the SCR. After adjustment, check fan's ability to restart after powering down. Increase SCR setting if required for proper starting.
c) CFM with Variable Pitch Blades: Variable fixed pitch fan blades and variable in-motion pitch fan blades shall be adjusted initially by the manufacturer at pitch required to provide design output. Check and readjust if necessary to obtain design cfm. Pitch angle adjustment shall not exceed recommended maximum to prevent "stall."

b. Outside Air:

1) Manual Dampers: Adjust manual dampers (and/or OSA fan capacity) as necessary to obtain design OSA cfm.
2) Automatic Dampers: Adjust the maximum open position of separate minimum OSA dampers (or the minimum open position of economizer OSA dampers) as necessary to obtain design minimum OSA cfm.
3) Quantity of OSA: Shall be measured directly using a velocity traverse (or pitot tube traverse when separately ducted), or shall be calculated using return air, OSA, and resultant mixed air temperatures.

c. Registers and Diffusers: Registers, diffusers, etc., are to be adjusted to deliver design air quantities per the “Requirements of Work” paragraph in this specification.

d. Motor Starter – Overload Trip Devices:

1) VFD, Magnetic, and Manual Starters furnished by the Mechanical Contractor: Exchange or reset overload devices as required for proper motor protection.
2) Motor Control Center (MCC) Magnetic Starters furnished by the Electrical Contractor: Check overload devices for correct sizing and/or setting. Notify the Electrical Contractor of any discrepancies.

8. When air balancing is done and manual dampers are set, all test holes shall be plugged and all manual damper positions shall be marked. The following information shall be recorded in the final report: Design inlet or outlet size, actual inlet or outlet size, and design cfm (velocity) through the orifice for each terminal in the system.

I. Electric Heat:

1. Record full load and part load (when staged) amperage and voltage of all electric heating elements.
2. Verify that electric heat is locked out when flow rate drops below minimum requirements.

J. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.3 FIELD QUALITY CONTROL

A. Upon request of the Commissioning Agent, Contracting Officer, a representative of the balancing firm performing the work shall demonstrate fluid flow quantities shown in the report by reading back outlets or terminals selected at random by the Contracting Officer. It is understood that the operating mode of the system shall be the same for read back as it was during balancing, and the number of readings verified will not exceed 10% of the total in the report. If rechecks fail, test and balance report will be rejected.

B. Equipment non-performance not resolvable by the Contractor and Commissioning Agent shall be reported to the Contracting Officer. Balancer shall assist the Contracting Officer, when requested, by providing field temperature, pressure and flow information at specific locations.

END OF SECTION 230593

SECTION 230700
MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. The word "concealed" as used in this section refers to insulation in ceiling plenums, furred spaces, pipe and duct shafts, unheated spaces immediately below roof and crawl spaces. The word "exposed" refers to insulation in other areas.

1.3 SYSTEM DESCRIPTION

A. Systems to be Insulated: Insulate portions of the following systems, equipment, and accessories, except where noted otherwise or furnished by OEM as part of equipment.

1. Ductwork:

a. Concealed HVAC supply, transfer, and return ductwork except as noted
b. Ducts exposed to weather
c. Exposed ductwork where noted

2. Items that need not be insulated:

a. Exposed ductwork in occupied spaces (unless otherwise noted)
b. HVAC return ductwork in return air plenums (unless otherwise noted)
c. Factory pre-insulated equipment

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, permeability, thickness, and jackets (both factory and field applied, if any). Submit a schedule showing on one document, each mechanical system or component to be insulated, and the product to be used on each system/component.

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger
2. Detail attachment and covering of heat tracing inside insulation
3. Detail insulation application at pipe expansion joints for each type of insulation
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation

5. Detail removable insulation at piping specialties, equipment connections, and access panels
6. Detail application of field-applied jackets
7. Detail application at linkages of control devices
8. Detail field application for each equipment type

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Protect insulation against dirt, water, chemical, or mechanical damage before, during, and after installation. Satisfactorily repair or replace any such insulation or covering damaged prior to final acceptance of the work.

B. 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 size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork shop drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

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 DUCT INSULATION

A. Specification “A”: 2-inch-thick fiberglass 3/4 lbs/ft^3. density blanket with factory-applied heavy duty FSK facing with a "K" value of 0.28 Btu-in./h-sf-°F maximum at 75°F mean temperature.

. Duct Insulation and Lining Schedule:

System	Insulation Spec	Thickness	Vapor Seal Required
1. HVAC supply	A	2"	No
2. HVAC return	A	2"	No

2.2 ADHESIVES

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

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

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-97
   b. Eagle Bridges - Marathon Industries; 290
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27
   d. Mon-Eco Industries, Inc.; 22-30
   e. Vimasco Corporation; 760

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK and PVDC 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.
    d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Provide materials compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. 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°F.
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

2.4 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.
    b. Eagle Bridges - 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°F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl and PVC 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.

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°F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 INSTALLERS

A. Install insulation with workers regularly engaged in this kind of work in strict accordance with the manufacturer's recommendations and recognized industry practices.

3.2 INSTALLATION

A. General:

1. Apply full-length units of insulation on clean, dry surfaces free of foreign matter. Apply only after tests and approvals required by the specifications have been completed.
2. Apply insulation on cold surfaces with a continuous, unbroken vapor seal. Provide insulation and vapor seal at supports, anchors, etc., that are secured directly to cold surfaces to prevent condensation.
3. Finish raw edges with finishing cement.

B. Blanket Insulation:

1. Apply insulation with edges tightly butted with facing overlapping joints at least 2 inches. Secure the insulation to the duct with approximately 4-inch-wid strips at 8 inch o.c. of fire-retardant adhesive. Where the duct width exceeds 30 inches, attach the underside insulation with mechanical fasteners on about 18-inchmaximum centers.

C. Other Requirements:

1. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.
2. Repair sections of mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation; install new jacket lapping and seal over existing.
3. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

END OF SECTION 230700

SECTION 230800
COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the commissioning process requirements for HVAC systems, assemblies, and equipment.

B. Related Requirements:
   1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
   2. For Pre-Functional Checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."

C. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

D. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

E. HVAC: Heating, ventilating, and air conditioning.

F. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."

G. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

H. TAB: Testing, Adjusting, and Balancing.

1.3 SYSTEMS TO BE COMMISSIONED

1. HVAC Systems:
   a. Air Handling Units.

b. Cabinet Unit Heaters.
c. Exhaust Fans.

B. Qualification Data: For HVAC testing technician.

C. Submittals: Submittals associated with commissioned systems.

D. Pre-Functional Checklists: Draft Pre-Functional Checklists will be created by CxA for Contractor review after receiving submittals accepted.

E. Functional Performance Tests: Material and installation checklists for equipment, and components to be part of the Cx process and according to requirements in Section 019113 "General Commissioning Requirements."

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC systems and components to include operation and maintenance manuals.

B. Record of Training of operation and maintenance personnel of commissioned systems.

1.5 QUALITY ASSURANCE

A. HVAC Testing Technician Qualifications: Technicians to perform HVAC pre-functional checklists and Functional Performance Tests shall have the following minimum qualifications:
1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
2. Minimum three years of experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Testing Equipment and Instrumentation Quality and Calibration:
1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

C. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
    a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 MEETINGS

A. Commissioning Kick-Off Meeting: Within 90 days of selection of contractors or within 90 days of award of this contract, the CxA will provide a kick-off meeting to review roles and responsibilities of contractors during the construction process.

B. Controls Coordination Meeting: After acceptance of controls submittal by the Engineer of Record, and prior to implementation, the CxA will organize a meeting to review the control sequences with the Contracting Officer, the Engineer of Record, the Controls Contractor, and the CxA.

3.2 SUBMITTALS

A. The CxA will provide the general contractor with a list of HVAC submittals to be reviewed.

B. The Contracting Officer will facilitate the distribution of submittals to the CxA.

C. The CxA will review HVAC submittals within 10 business days

3.3 PRE-FUNCTIONAL CHECKLISTS

A. Review and provide written comments on draft Pre-Functional Checklists. CxA will create required draft Pre-Functional Checklists and provide them to Contractor.

B. Return draft pre-functional checklist review comments within 10 business days of receipt.

C. When review comments have been resolved, the CxA will provide final Pre-Functional Checklists.

D. Mechanical, Electrical, and Controls contractors will fill out their respective sections of the pre-functional checklists and note any outstanding deficiencies.

E. Comply with Pre-Functional Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying plumbing systems and equipment.

F. FUNCTIONAL PERFORMANCE TESTING

G. Prior to functional testing, checks for the following conditions will be made:
   1. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating per the Contract Documents and approved submittals. Contractors will document this information by filling out pre-functional checklists and providing start-up report.
   2. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved submittals, and that pretest set points have been recorded.
   3. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved. A preliminary TAB report accepted by the CxA will serve as acceptable documentation.
   4. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

H. Functional Performance Test Conditions Perform tests using design conditions, whenever possible.
      a. Simulated conditions may be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
      b. Functional Performance Test procedures may direct that set points be altered when simulating conditions is impractical.
      c. Functional Performance Test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
   2. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Contracting Officer. After deficiencies are resolved, reschedule tests.

I. Functional Performance Tests Common to HVAC Systems
   1. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

2. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.
3. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
4. Comply with pre-functional checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Division 23 Sections specifying HVAC systems and equipment.
5. Contractor will provide technicians, instrumentation, tools, and equipment to perform and document the following:
    a. Pre-functional checklists.
    b. Functional Performance Tests.

J. Execution of Functional Performance Test Procedures
1. The CxA will provide functional test procedures.
2. The controls contractor will execute functional test procedures. The CxA will witness and provide direction for execution of testing procedures.
3. The CxA will document the test process, document issues, and notify contractors of outstanding issues. Contractors will correct outstanding issues.
4. Acceptance Criteria: Operation of equipment according to OPR and BOD.

END OF SECTION 230800

This page intentionally left blank

SECTION 231123
FUEL GAS PIPING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data: Submit product data for the following items:

1. Valves, manual and automatic
2. Pressure-reducing stations
3. Gas meters

B. Wind Resistance Data: For all systems and equipment installed outdoors, submit shop drawings indicating the design of the supports and curbs, the attachments to supports and curbs, and the attachment of the support and curbs to the structure, slab, or grade as required to provide resistance to the wind forces identified in specification section 23 0548 “Wind, and Vibration Controls”.

C. Closeout Submittals: Submit operating and maintenance instructions on the following items.

1. Valves, manual and automatic
2. Pressure-reducing stations
3. Gas meters

1.3 QUALITY ASSURANCE

A. Certifications: All fittings, valves, PRVs, etc., shall be UL recognized or AGA/API certified for fuel gas service.

1.4 SEQUENCING/SCHEDULING

A. Coordinate all work with all other trades and utility companies for elimination of interference; utilization of combined hanger support systems; timely routing and installation of systems; verifications of existing utilities, locations, depths, and connection regulations; and proper valving and junction structures or fittings. Location and furnishing of pressure-reducing stations and/or meters as applicable and appropriate.

1.5 GAS SERVICE

A. Existing gas service is to be utilized to serve the new equipment. Notify the local gas utility as to new connected loads.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Interior Exposed, with Operating Pressures up to 14 inch w.c.:

1. Size NPS 1/2 through NPS 2:

a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
b. Malleable Iron Fittings: ASME B16.3, Classes 150, standard pattern.
c. Unions: ASME B16.39, Class 150, malleable-iron, with brass to iron seat, ground joint.
d. Joint Seal: Teflon.

B. Interior Concealed, with Operating Pressures up to 14-inch w.c.:

1. Size NPS 1/2 and Over:

a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
b. Wrought Steel Fittings: ASTM A 234, seamless or welded; ASME B 16.9, butt welding type; and ASME B16.11, socket-welding type.
c. Unions: ASME B16.39, Class 150, malleable-iron, with brass to iron seat, ground joint.

C. Exterior Aboveground with Operating Pressures to 5 psig:

1. Size NPS 1/2 through NPS 2:

a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
b. Malleable Iron Fittings: ASME B16.3, Classes 150, standard pattern.
c. Unions: ASME B16.39, Class 150, malleable-iron, with brass to iron seat, ground joint.
d. Joint Seal: Teflon.

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.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.

8. Maximum Length: 72 inches.
9. NSF Certified for kitchen appliances

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.

2.3 GAS VALVES

A. Manual Shutoff Valves:

1. Steel Pipe: Two –piece ball type forged brass body, 175 psig WOG, UL, AGA, or API recognized for fuel gas service. Threaded ends for NPS 3 or smaller. Apollo 80-100-1 or Nibco 585.
2. PE Pipe: Plug type through NPS 1-1/4, ball type for NPS 2 to NPS 4, ASTM D-2513, 80 psig minimum allowable pressure rating. Material and SDR to be same as PE pipe material. Rockwell “Polyvalve” or approved equal.

2.4 GAS PRESSURE REGULATORS (COMMERCIAL)

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 and smaller.

B. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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. 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: 1 psig.

2.5 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 wide and 4 mils 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 deep; colored yellow.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Provide all fuel gas piping from source to each connection point of all gas-fired equipment items. Provide a drip leg, gas shutoff valve, and union for each equipment item. Make final connections in compliance with equipment manufacturer's instructions. Flexible connections will not be allowed, except where explicitly specified or shown.

B. Piping:

1. General:

a. Install fuel gas distribution piping in accordance with jurisdiction codes, local utility company requirements, and NFPA 54.
b. Install a "Tee" fitting with a drip leg at the bottom of pipe risers or drops, fitted with full size 6-inch-long nipples capped at the bottom.
c. Use dielectric unions where dissimilar metals are joined together.
d. Use Teflon joint seal on metal gas piping threads.
e. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.
f. Install gas shutoff valve and strainer ahead of gas pressure regulators.
g. Gas pressure regulators shall be accessible and vented to the outside of the building.
h. Paint exterior pipe per Section 23 05 00.
i. Refer to Division 23 Section 23 05 29, "Hangers and Supports for HVAC Piping and Equipment," for additional installation requirements. Refer to Division 23Section "Wind, and Vibration Controls for HVAC" for wind restraints.

3. Concealed Locations:

a. Above Ceilings: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such

spaces are used as a plenum. Valves shall not be located in such spaces, and all gas piping shall be welded.

4. Prohibited Locations:

    a. Do not install gas piping in or through a circulating air duct, chimney or gas vent, or ventilating duct. (This does not apply to accessible above-ceiling space specified above.)
    b. Gas piping shall not be installed in or on the ground under any building or structure, and exposed gas piping shall be kept at least 6 inches above grade or structure. The term "building or structure" shall include structures such as porches and steps (whether covered or uncovered), and similar structures or appurtenances.

5. Protective Coating: When metallic piping and fittings will be in contact with material or atmosphere exerting a corrosive action or installed below grade, all pipe and fittings shall be factory or field wrapped with polyethylene tape having the following properties:

    a. Overall thickness: 20 mil (50% overlap)
    b. Synthetic adhesive
    c. Water vapor transmission rate: 0.10 gallon per 100 square inches, or less
    d. Water Absorption: 0.02% or less
    e. All fittings shall be double-wrapped 40 mil

C. Gas Valves:

1. Provide at supply runout connection for each gas-fired equipment item, at building entry, and on risers and branches where indicated.
2. Locate gas valves where easily accessible and where they will be protected from possible damage. Install per manufacturer's recommendations.
3. Do not install gas valves in plenums or concealed locations. Use a valve ceiling enclosure when shutoff valves are to be located in accessible ceilings.

D. Unions, and Strainers:

1. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
2. Install strainers on the supply side of each control valve, pressure-reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

E. Electrical Bonding and Grounding:

1. Install aboveground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 of the National Electrical Code.
2. Do not use gas piping as a grounding electrode for other systems.

3. Conform to NFPA 70 - “National Electrical Code” for wiring and electrical connections to electrically operated control devices.

F. Equipment Gas Pressure Regulators:

1. Install regulators per manufacturer’s recommendations and comply with utility requirements. Pipe atmospheric vents full size to outdoors. Install gas shutoff valve upstream of each pressure-regulating valve.

a. Install NPS 3/8 plugged gauge tap both upstream and downstream (10 pipe diameters straight pipe where possible) of each regulator.

2. Do not install regulators in plenums or concealed locations.

3.2 FIELD QUALITY CONTROL

A. Testing:

1. All piping specified in this section shall be tested.

a. All joints, fittings, and piping accessory items shall be exposed to view during tests whether pipe is above or below ground. "Closed-in" or "buried" piping shall be re-exposed during testing.
b. Proper restraining of piping and test plugs shall be accomplished prior to test.
c. Test connections can be anywhere in the system. Use certified 6-inch gauge with 1 psi division.
d. In the event that tests fail, use a standard soap and brush inspection using "Trouble Bubble" liquid high density soap as manufactured by Jersey Meter Co., Patterson N.J. Formula ST-1. After source of failure is discovered, correct and retest system. Repeat procedure until system successfully sustains required testing.

2. Testing shall be of the complete piping system, before covering, or of individually separable larger portions of the system. Only the last connection to the appliance may be tested under operating conditions. This connection will be tested with soap and brush under line pressures. This connection must remain exposed.
3. Test Procedures: As required by Administrative Authority and NFPA 54.

a. 15-inch w.c. to 5 psig Systems: 60 psig air pressure for a period of 2 hours with no drop in gauge pressure.
b. 14-inch w.c. or Less: 10 psig air pressure for a period of 1 hour with no drop in gauge pressure.

4. Retesting: Retest any piping failing initial tests following correction of defective work. Requirements of initial tests shall apply.

5. Verification of tests shall be made by the plumbing inspector, Commissioning Agent, and Contracting Officer.

    a. Testing contractor shall arrange a time and date with the Contracting Officer so arrangements can be made for witnessing tests.
    b. Record pressure and ambient temperature at start and end of test. Submit written results of tests to the Contracting Officer.

END OF SECTION 231123

This page intentionally left blank.

SECTION 233100
DUCTS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data for all items in this section:

B. 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 , signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports not addressed in cataloged, pre-engineered product data.

C. Welding certificates.

D. Wind Resistance Data: For all systems and equipment installed outdoors, submit shop drawings indicating the design of the supports and curbs, the attachments to supports and curbs, and the attachment of the support and curbs to the structure, slab, or grade as required to provide resistance to the wind forces identified in specification section 23 0548 “Wind, and Vibration Controls”. Where there is no product of this section installed outdoors, no such submittal is required.

E. Closeout Submittals:

1. Backdraft and relief dampers

1.3 QUALITY ASSURANCE

A. Comply with AMCA 500-D testing for damper rating.

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

1. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports
2. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2019, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2019, Section 6.4.4 - "HVAC System Construction and Insulation."

1.4 PERFORMANCE REQUIREMENTS

A. Contractor shall furnish and install ductwork and accessories, including offsets and size transitions, which may become evident during the course of construction, to avoid building construction and other considerations, to provide a complete and operational system.

B. 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 specified design criteria.

C. Structural Performance: Duct hangers and supports shall be designed to withstand the effects of gravity, and wind loads and stresses within limits and under conditions described in the locally adopted Building Code.

D. Air stream Surfaces: Surfaces in contact with the air stream shall comply with requirements in ASHRAE 62.1.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View or Weather: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inchminimum diameter for lengths longer than 36 inches.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the duct airway size. Allowance for liner thickness must be added to airway size to determine sheet metal size.

B. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Rectangular Duct Construction" based on indicated static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 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."
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal 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." Button punch lock, detail L-2, is not acceptable.
3. 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."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. Round Ducts: Fabricate ducts with indicated dimensions for the inner duct airway size. Allowance for liner thickness must be added to airway size to determine sheet metal size.

B. 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.

1. 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."

    a. Transverse joints in ducts larger than 60 inches in diameter shall be flanged.

2. 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." Snap lock seams, RL-6A, RL-6B, RL-7, and RL-8 and lap rivets, RL-3 and RL-4 are not acceptable.

a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

3. Laterals and Tees Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals" Saddle Taps are not allowed, and SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-6, "Conical Tees" Saddle Taps are not allowed for static pressure class, applicable sealing requirements, materials involved, duct support intervals and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 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 723certified by a nationally recognized testing laboratory.

B. 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-inch.
2. Manufacturer: Carlisle Hardcast DT-5300-Tape with RTA-50 coating or approved equal.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10" w.g., positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to 200°F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Manufacturer: Carlisle Hardcast DS-321 coating or approved equal.
2. Application Method: Brush on.
3. Solids Content: Minimum 65%.
4. Shore A Hardness: Minimum 20.
5. Water resistant.
6. Mold and mildew resistant.
7. VOC: Maximum 75 g/L (less water).

8. Maximum Static-Pressure Class: 10” w.g., positive and negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
11. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Round Duct Joint O-Ring Seals: Seal shall provide maximum leakage class of 3 cfm/100 sq ft at 1” w.g.and shall be rated for 10” w.g. static-pressure class, positive or negative.

1. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
2. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Stainless steel Ducts: Stainless steel complying with ASTM A 492.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.6 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Approved Manufacturers:

1. Air Balance
2. American Warming and Ventilating
3. Arrow, Cesco
4. Safe Air/Dowco
5. Duro Dyne
6. Greenheck
7. Louvers & Dampers
8. Nailor
9. Pottorff
10. Ruskin

11. Vent Products
12. Venco

B. Metal Type Backdraft

1. Maximum Static Pressure: 1” w.g.
2. Up to 1,500 fpm: 0.063-inchminimum extruded aluminum frame, 0.021-inch formed blades with vinyl blade seals. AWV BD-16, Ruskin BD2/A1 or approved equal.
3. 1,500 to 2,500 fpm: 0.090-inchminimum extruded aluminum frame, 0.050-inchformed blades with vinyl blade seals. Ruskin BD2/A2 or Engineer approved equal.

C. Counter-Balanced Pressure Relief

1. Description: Gravity balanced.
2. Maximum Air Velocity: 2500 fpm.
3. Maximum System Pressure: 2” w.g.
4. Frame: 16-gaugegalvanized steel hat channel or 0.125-inch extruded aluminum minimum.
5. Blades: Multiple, single piece blades, 16-gaugegalvanized steel formed or 0.070-inch, vinyl blade seals.
6. Blade Action: Parallel.
7. Blade Seals: Extruded vinyl mechanically locked.
8. Adjustable counterbalance or static pressure control to relieve at 0.25-inch to 0.75” w.g. (37 Pa to 190 Pa), adjustable.
9. Blade Axles: 0.20 inch aluminum or galvanized steel.
10. Linkage: Aluminum or galvanized steel.
11. American Warming and Ventilating BQ-40, Ruskin CBD 6, or Engineer approved equal.

2.7 MANUAL VOLUME DAMPERS

A. Manufacturers:

1. Air-stream
2. Air Balance
3. American Warming and Ventilating
4. Arrow
5. Cesco
6. Safe Air/Dowco
7. Duro-Dyne
8. Greenheck
9. Louvers & Dampers
10. Nailor
11. Pottorff
12. Ruskin
13. Vent Products
14. Venco

B. Rectangular, Steel

1. Manufacturer: Ruskin MD35, Greenheck MBD-15 or equal
2. Type: Parallel blade or opposed blade with concealed or exposed linkage, all galvanized steel or all stainless steel
3. Maximum Velocity: (1,500 fpm)or less
4. Frame: 16-gauge, roll formed channel
5. Blades: 16-gauge
6. Maximum Blade Width: 8 inches, exception: single blade up to 12 inches
7. Blades 36 inches and longer and driven blade shall be furnished with reinforcing cone. Maximum blade length is 48 inches
8. Shafts: 1/2-inch
9. Bearings: Synthetic

C. Round, Steel

1. Manufacturer: Ruskin MDRS25, Greenheck MBDR-50 or equal.
2. Type: Single blade up to 20-inch diameter; use rectangular steel with round adapter above 20-inch diameter.
3. Maximum Velocity: (2,000 fpm) or less.
4. Frame: 20-gauge galvanized steel or stainless steel.
5. Blades: 20-gauge galvanized steel or stainless steel.
6. Shafts: 0.375-inch square.
7. Bearings: Synthetic.

D. Damper Actuators: Provide locking quadrant operators on all dampers unless otherwise noted on plans

2.8 FLEXIBLE CONNECTORS

A. Manufacturers

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4”-wide x 0.028”-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..

2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200°F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250°F.
4. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
5. Minimum Weight: 16 oz./sq. yd..
6. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
7. Service Temperature: Minus 67 to plus 500°F.

2.9 FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC
3. Ward Industries, Inc.; a division 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; aluminized vapor-barrier film.

1. Pressure Rating: 10” w.g. positive and 1.0” w.g. negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160°F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2007.

C. Flexible Duct Connectors: Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action.

2.10 MANUFACTURED DUCT CONNECTORS

A. For rectangular duct, Ductmate WDCI J & H or Ductmate 25/35/45 duct connection systems. Connectors shall be installed in strict accordance with the manufacturer’s instructions. Connector material shall be the same as the ductwork material. Or Engineer-approved equivalent.

B. For spiral ductwork, Ductmate Spiralmate. Connectors shall be installed in strict accordance with the manufacturer's instructions. Connector material shall be the same as the ductwork material. Or Engineer-approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Duct Installation:

1. 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 ductwork systems including field identified offsets and adjustments required to avoid conflict with building construction and other conditions. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings, Coordination Drawings, or Requests for Information.
2. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
3. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
4. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel.
5. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
6. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
8. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
9. 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.
10. All ductwork shall be fabricated and installed so that no undue vibration or noise results. Joints per seal class shall be sealed airtight with additional taping and caulking provided if necessary.
11. Provide all necessary manual, backdraft, and relief dampers as required for proper adjustment and control of air distribution.

    a. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.
    b. Install steel volume dampers in steel ducts.
    d. Set dampers to fully open position before testing, adjusting, and balancing.
    e. Backdraft and relief dampers shall be installed per the manufacturer's recommendations.

12. At all places where inside of duct will be visible through grilles, louvers, etc., paint visible inside portion of duct flat black.
13. Install flexible connectors to connect ducts to equipment.

14. Transitions in ductwork, in changing shapes and sizes, shall be made with angles not exceeding 15 degrees (diverging) or 30 degrees (converging) wherever possible.
15. Flexible duct shall be used on supply diffuser run outs only, and only where indicated. Flexible ducts shall be installed using lengths not exceeding 6 feet (low-pressure) to make the connection. Duct shall be suspended at intervals not exceeding 5 feet with a minimum 1-inch-wide, 22-gauge steel band. Maximum allowable sag is 1/2 inch per foot (1:25) of spacing between supports.
16. Flexible duct shall be installed such that obstructions do not crush, distort or otherwise intrude on the flexible duct.
17. Contractor shall not provide holes in the duct systems for the installation of hangers for other equipment. Work of all other trades shall be so coordinated as to render this unnecessary.
18. At ends of ducts that are not connected to equipment, ductwork, or air distribution devices at time of ductwork installation, provide a temporary closure of plywood or corrugated cardboard backed polyethylene film or other covering that will prevent entrance of moisture, dust, and debris and duct leakage until time connections are to be completed.

B. Duct Penetrations through Wall and Floors:

1. Provide 1-inchangle collars for all exposed ducts passing through walls, ceilings, or floors. Anchor collars in position after installation is complete.
2. Where vertical ducts pass through floors, supporting angles shall be rigidly attached to ducts and to the floor. Angles shall be galvanized and of approved sizes to properly support the ductwork. The supporting angles shall be placed on at least two sides of the duct.
3. Where horizontal ducts pass through walls and vertical ducts pass through floors, opening shall be tightly sealed off so as to provide a tight seal between duct and opening. Refer to Division 07 for approved fire stop materials to be used at all rated walls and floors.

3.2 DUCT PROTECTION

A. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction."

B. Store duct sections on jobsite in clean, dry area. Duct ends and openings shall be covered and protected from dirt and moisture.

C. Cover and protect duct openings from dirt and moisture during and after erection.

D. Cover return ducts openings with MERV 8 filters whenever air handlers are operated during construction.

E. Submit statement and photographs documenting duct protection.

3.3 SEALING OF DUCTS

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."

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class B.
4. Outdoor, Return-Air Ducts: Seal Class B.
5. Conditioned Space, Supply-Air Ducts in Pressure Classes 2” w.g. and Lower: Seal Class A.
6. Conditioned Space, Exhaust Ducts: Seal Class A.
7. Conditioned Space, Return-Air Ducts: Seal Class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for metal ducts and fittings to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Attachments and Spacing:

1. Building Attachments: Verify attachment methods with structural drawings. Use concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
2. Where practical, install concrete inserts before placing concrete.
3. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
4. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
6. Do not use powder-actuated concrete fasteners for seismic restraints.
7. Hanger Spacing: Comply with SMACNA for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection unless more restrictive by SMACNA.
8. Hangers Exposed to View: Threaded rod and angle or channel supports.
9. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
10. 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 DAMPERS

A. Install backdraft and control dampers on exhaust fans as near the building envelope exit as possible, unless otherwise indicated on drawings.

3.6 CONNECTIONS

A. Provide flexible and fabric connections at inlet and discharge duct connections to air handling equipment, except when fans are internally isolated. Flexible connections shall be securely fastened to the duct and equipment per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Allow at least 1 inch of slack.

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.

B. Paint materials and application requirements are specified in Division 09 painting sections.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L
2. Nonflat Paints and Coatings: 150 g/L

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect turning vanes for proper and secure installation.
3. Operate remote damper operators to verify full range of movement of operator and damper.

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Air Handling Units:

a. Pressure Class: Positive 3" w.g.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 3.
d. SMACNA Leakage Class for Round: 2.

C. Return Ducts:

1. Ducts Connected to Air Handling Units:

a. Pressure Class: Positive or negative 2” w.g.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2” w.g.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round: 3.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-width ratio.
b. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," with 1-1/2-inch spaced and 2-inch radius, small single width vanes and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows.”

a. Minimum radius-to-diameter ratio shall be 1.5 and elbow segments shall be 5: Elbows with less than 90-degree change of direction have proportionately fewer segments.
b. Radius-to Diameter Ratio: 1.5.
c. Round Elbows, 12 inches and Smaller in Diameter: Stamped or pleated.
d. Round Elbows, 14 inches and Larger in Diameter: Standing seam or Welded.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin-in.
c. Branch to Run Out: Conical spin-in with damper.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity to 1500 fpm: Conical tap.
b. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233100

SECTION 233400
FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data: Product data for selected models, including specialties, accessories, certified fan performance curves, certified fan sound power ratings, motor ratings, and electrical characteristics.

B. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

C. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

1.3 QUALITY CONTROL

A. Certificates: Fans shall bear the AMCA Certified Sound Ratings Seal.

PART 2 - PRODUCTS

2.1 FANS (GENERAL)

A. Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

B. Fans and shafts designed for continuous operation at the maximum rated fan speed and motor horsepower.

2.2 CABIENT VENTILATORS

A. Manufacturers: Acme, Carnes, Greenheck, Jenn Fan, Loren Cook, Penn Ventilator, and Twin City Fan and Blower.

B. Centrifugal fan designed for installation in ceiling, wall, or concealed in-line applications.

C. Housings shall be galvanized steel lined with acoustical insulation. Discharge configuration shall be interchangeable between up discharge or side discharge and shall include an integral backdraft damper.

D. The fan wheel shall be centrifugal type directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. The motor shall be permanently lubricated, open drip-proof, split-capacitor motor, with grounded cord and plug.

F. Provide remote fan speed control, solid state, capable of controlling fan speed from full speed to approximately half speed.

G. Provide stainless steel or aluminum grille with flange on intake and thumbscrew attachment to fan housing.

H. Provide manufacturer's standard roof jack, wall cap, or transition fittings as indicated or as scheduled on the drawings.

2.3 FINISHES

A. The following factory finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.4 SOURCE QUALITY CONTROL

A. Test fans in accordance with AMCA Standard 300, "Test Code for Sound Rating."

B. Fans and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fans level and plumb in accordance with manufacturer's written instructions.

B. Arrange installation of units to provide access space around fan for service and maintenance.

C. Mount or suspend units on vibration isolators and secure to withstand overturning forces.

3.2 CLEANING

A. Adjusting, Cleaning, and Protecting: Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

END OF SECTION

SECTION 233700
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.3 SUBMITTALS

A. Product Data:

1. For each model indicated, include the following:

a. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
b. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
c. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
d. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

2. Provide sufficient submittal data for air distribution devices to verify that required space sound levels will not be exceeded.

1.4 SYSTEM DESCRIPTION

A. Performance Criteria: All equipment and material furnished under this section shall be selected so required RC sound levels in various spaces are not exceeded. Attenuation by ceilings, duct liner, and room absorption may be taken into account when making fan, terminal unit, and air distribution selections. Refer to the latest edition of the ASHRAE Applications Handbook for further information.

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS, AND DIFFUSERS

A. Approved Manufacturers: Anemostat, Carnes, Carrier, Krueger, Metal Aire, Nailor, Price, Tempmaster, Titus, Trane, and Tuttle & Bailey.

B. Air outlets and inlets shall be performance tested and rated in accordance with and ASHRAE Standard 70 "Method of Testing for Rating the Performance of Air Outlets and Inlets."

C. Provide grilles, registers, diffusers, slots, and accessories of size and type as indicated and/or scheduled on the drawings. Select devices so required space RC sound levels are not exceeded.

D. All grilles, registers, and diffusers shall have white baked-on enamel finish.

E. Provide ceiling grilles, registers, and diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. (Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling diffuser.)

1. Provide trim frames on all surface mount diffusers installed in gypsum board construction.

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. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Grilles, Registers, and Diffusers:

1. Grilles, registers, and diffusers shall be installed level and plumb and supported per manufacturer's recommendations and per the International Building Code.

    a. Ceiling-mounted air devices (supply diffusers and/or return and exhaust grilles and registers) or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.

2. Ductwork visible behind grilles, registers, and diffusers shall be painted flat black.
3. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

4. Refer to architectural reflected ceiling plan for locations of grilles, registers and diffusers.

3.3 ADJUSTING

A. Grilles, Registers, and Diffusers: Throw patterns (directions) shall be furnished and/or adjusted to match those noted on the drawings.

END OF SECTION 233700

This page intentionally left blank.

SECTION 234000
AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data: Include dimensions; shipping, installed, and operating weights; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated. Submit on the following:

1. Air filters
2. Filter gauges
3. Filter racks

1.3 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1-2019, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.1 FILTERS AND GAUGES

A. Approved Manufacturers: American Air Filter, BLC Industries, Cam-Farr, Flanders, and Fiberbond.

1. Type of filters and housings shall be as noted or scheduled on the drawings.
2. Fractional particle size efficiencies shall be as determined per ASHRAE Test Standard 52.2.

B. Specification "F-D," Disposable Pleated Filters (Medium Efficiency):

1. Air filters shall be medium efficiency, pleated, disposable type, 2 inches thick. Each filter shall consist of media, media support grid, and enclosing frame. The filter shall be listed by Underwriters' Laboratories as Class 2
2. Filter media shall be lofted, non-woven cotton fabric or glass fiber. The filter media shall have a MERV 8 rating in accordance with ASHRAE Test Standard 52.2.
3. The area ratio of effective filter media to filter face area shall be not less than 2 inches = 4.6 and shall contain not less than 2 inches = 14 pleats per linear foot. Initial resistance at 500 fpm approach velocity shall not exceed 0.30-inch w.g.
4. The media support shall be a welded wire grid with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away. The media support grid shall be formed in such a manner that it effects a radial pleat design, allowing total use of filter media.
5. The enclosing frame shall be constructed of a rigid, heavy-duty, high wet-strength beverage board, with diagonal support members bonded to the air entering and air exit side of each pleat, to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack to eliminate the possibility of air bypass.
6. Holding frames shall be AAF Universal Style, factory fabricated of 16-gauge galvanized steel for 2-inch) disposable filters, and shall be equipped with gaskets and four positive sealing fasteners. Fasteners shall be capable of being attached or removed without the use of tools.

C. Filter Holding Systems:

1. Filter holding systems for F-D filters shall be factory-assembled, side access, two-stage assemblies consisting of a housing, access doors, and filter tracks.
2. The housing shall be constructed of 16-gauge galvanized steel with access doors on each side to allow filter removal from both sides of the unit. The housing shall have tracks to accommodate 2-inch prefilters and primary filters The in-line depth of the assembly shall not exceed 21 inches
3. The access doors shall have adjustable, replaceable, positive sealing door latches. The perimeter of the door opening shall have a continuous neoprene gasket to seal between the housing and the access door.
4. The tracks shall be constructed of 18-gauge aluminum with positive sealing gaskets to prevent air bypass. Blank-off panels shall be provided for systems with filter sizes that do not match the housing size.
5. Provide a static pressure tap at the primary filter section
6. The leakage, at rated airflow, out of the assembly shall not exceed 1% at 3.0-inch w.g. positive and into the assembly shall not exceed 0.5% at 3.0-inch w.g. negative.

D. Two complete sets of filters shall be supplied for use during the construction and testing and balancing period. Another set of new filters shall be installed after testing and balancing. Four spare sets to be turned over to the owner, seven sets.

E. Each filter bank shall have a Dwyer 2000 series, magnahelic differential pressure gauge. These gauges shall be installed to measure the differential pressure across each filter bank. Each gauge shall have a suitable range to indicate clean loading and dirty filter conditions. Provide Model A-605 air filter kit with mounting panel and accessories for each 2000 series gauge.

PART 3 - EXECUTION

3.1 FILTERS AND GAUGES

A. Install filter frames per manufacturer's recommendations in locations where scheduled and/or shown on the drawings.

B. Install filter gauge (magnahelic type) across each filter bank. Mount gauge on duct or AHU in a position easily visible from floor level where possible. Location of filters and gauges in plenums above accessible ceilings shall be identified with an identification tag attached to the ceiling grid at each different location.

C. Two sets of filters may be utilized during the construction and TAB phases. The third set shall be installed after all construction is complete, spaces served are clean, and the HVAC system(s) are ready for "beneficial use" by the Government. Provide 4 spare sets of filters for each roof top unit.

END OF SECTION 234000

This page intentionally left blank.

SECTION 237400
PACKAGED ROOFTOP AND UNITARY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Specifications Sections

1. 23 05 25 VFD's For HVAC Systems
2. 23 05 00 Common Work Results for Mechanical Systems
3. 23 05 48 Wind Controls for Mechanical Systems
4. 23 40 00 Air Cleaning Devices

1.2 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including:

1. Rated capacities of selected models clearly indicated
2. Fan performance, including performance data showing brake horsepower, rpm, and static pressure characteristics from minimum flow to at least 125% of design flow.
3. Dimensions
4. Required clearance
5. Certified shipping, installed, and operating weights
6. Furnished specialties and accessories
7. Motor data (rpm, frame, efficiency, service factor, and voltage/current)
8. Damper construction and leakage rates
9. Installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, method of field assembly, components, and location and size of each field connection. Detail mounting, securing and flashing of roof curb to roof assembly. Indicate coordinating requirements with roof membrane system.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems specific to furnished equipment and differentiate between manufacturer-installed and field-installed wiring. Identify control interface points.

D. Startup Reports: Indicate results of startup and testing requirements. Submit copies of checklists.

E. Wind Resistance Data: For all systems and equipment installed outdoors, submit shop drawings indicating the design of the supports and curbs, the attachments to supports and curbs, and the attachment of the support and curbs to the structure, slab, or grade as required

to provide resistance to the wind forces identified in specification section 23 05 48, “Wind, and Vibration Controls”.

F. Closeout Submittals: Operation and Maintenance Manual, specific to the unit being furnished, shall include:

1. Complete technical description of operation of the unit
2. Complete setup instructions
3. Troubleshooting guide
4. Complete parts list with part number identification
5. A list of recommended spare parts with pricing

1.3 QUALITY ASSURANCE

A. These units shall be constructed to meet the applicable portions of ASHRAE Standard 15-2019, Safety Code for Mechanical Refrigeration.

B. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1-2019, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. ASHRAE/IESNA 90.1-2019 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2019, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Units shall be AGA approved. Comply with AGA Z223.1 for gas-fired furnace section.

E. Units shall have been rated in accordance with applicable portions of ARI Standards 210/240-05.

F. Sound ratings shall be per ARI Standard 270-2015.

G. Unit shall be UL listed and shall meet UL standard for rain resistance (no moisture penetration during 12 inches per hour rainfall).

H. All factory wiring shall be in accordance with NEC and NEMA requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver rooftop units as factory-assembled units with protective crating and covering.

B. Coordinate delivery of units in sufficient time to allow movement into building.

1.5 SYSTEM STARTUP

A. The manufacturer shall provide startup and testing service/assistance.

1.6 WARRANTY

A. Refer to Division 23 Section “Common Work Results for HVAC" for general warranty requirements.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Packaged Rooftop Air Conditioning Units:

1. Aaon
2. Carrier Corporation
3. Engineered Air
4. Lennox Industries
5. McQuay International
6. Trane Company
7. York International Corp.

2.2 PACKAGED ROOFTOP AIR CONDITIONING UNITS (SMALLER THAN 6 TONS)

A. Description: Factory assembled and tested; one-piece construction; designed for roof or slab installation; air-cooled direct expansion utilizing 410A refrigerant, natural gas heat; and consisting of condensers, compressors, evaporator coils, condenser and evaporator fans, refrigeration, and temperature controls, filters, and dampers. Roof curb shall be a separate component.

B. The airflow, heating, and cooling capacities, unit configuration, and overall unit dimensional constraints shall be as scheduled and as shown on the drawings.

C. Casing: Manufacturer's standard construction with electrostatically bonded fade-resistant baked enamel or epoxy finish, removable panels or access doors with neoprene gaskets for inspection and access to internal parts, minimum 1/2-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs, with surface coating specifically formulated so it will not support fungal or bacterial growth per tests in accordance with ASTM C 1071 and G21/G22 Standards.

1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2019.

    a. Insulation in contact with airstream shall comply with ASTM C 1071, Type I or Type II.

D. Evaporator Fans: Forward-curved, centrifugal with two-speed, direct-drive, permanently lubricated motor, equipped with built-in overload protection.

E. Condenser Fans: Direct-drive propeller equipped with permanently lubricated bearings.

F. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing type vertical distributor. Pressure tested to two times the normal operating pressure. Provide metal guard to protect condenser coil from hail and vandalism.

G. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.1-2019.

H. Refrigerant circuit(s) shall be factory sealed and shall have suction and liquid-line gauge ports, moisture indicator and liquid-line strainer, and shall be furnished fully charged with refrigerant and oil.

I. Compressors: Hermetic with integral vibration isolators and crankcase heaters.

J. Heat exchangers: Manufacturer's standard construction for heat exchangers and burners with the following features:

1. Redundant gas valves
2. Intermittent pilot ignition
3. Electronic-spark ignition system
4. High-limit cutout
5. Induced-draft proving switch
6. High altitude kit

K. Economizer Control: The economizer package shall include return and outside air dampers, outdoor air filter and weather hood with screen, and fully modulating electronic control system. Economizer shall be capable of introducing up to 100% outside air and have complete controls for changeover from economizer to DX cooling. Outside air dampers shall have adjustable minimum outside air position.

1. Economizer shall open to adjustable minimum OSA position whenever system is in occupied mode.
2. Economizer (when used) shall modulate beyond minimum call for cooling. OSA damper shall return to minimum position whenever outdoor air temperature exceeds 72°F (adjustable).
3. A further call for cooling will enable DX stage(s) as needed.

L. Manual Outside Air Dampers: Provide with rain hood and screen; suitable for up to 25% outside air.

M. Barometric relief damper shall include damper assembly, hood, damper screen, seals, and hardware and shall be located in a manner that minimizes recirculation of exhausted air into the unit's outdoor air intake.

N. Low Ambient Control: Head-pressure control, designed to operate at temperatures as low as 30°F.

O. Thermostat:

1. Room thermostat shall sequence heating and DX cooling with full integration of economizer
2. Thermostat shall have digital clock with battery backup that shall provide for seven-day programming; two occupied/unoccupied cycles per day with without system and fan switches.

P. See Division 23 "Air Cleaning Devices" for filters, rack and gauges.

Q. Roof curb shall be a minimum of 8 inches above the roof surface, fully insulated with 2-inchglass fiberboard. Curb shall include all internal supports and duct openings. See 23 05 48 “Wind, and Vibration Controls” for wind resistance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with drawings and manufacturer's recommendations.

B. Factory roof curbs shall be flashed to roofing system r per roofing vendor's recommendations. Unit shall be attached to curb, and curb shall be attached to the roof as required to meet the wind or seismic criteria in 23 05 48 “Wind and Vibration Controls for Mechanical Systems”

C. Gas Coil Piping Connections: Provide shut-off valves and drip leg and as further detailed on drawings. Verify appliance regulator maximum inlet pressure and provide suitable upsteam regulator as required.

D. All field gas and electrical connections shall be per AGA, NEC, and local code requirements.

E. All roof penetrations for gas and/or electrical service shall be inside curb or shall be done in a manner as approved by the Contracting Officer and the roofing vendor.

F. Gas piping on the roof shall be supported per detail on plans, or as approved by the Contracting Officer and the roofing vendor.

G. Install filters during construction, testing and balancing. Replace filters at beneficial occupancy.

END OF SECTION 237400

SECTION 238123
COMPUTER ROOM UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data: Submit complete product information and performance data for all units.

B. Shop Drawings: Power and control wiring diagrams.

C. Quality Assurance/Control Submittals: Submit field quality-control test reports.

D. Wind Resistance Data: For all systems and equipment installed outdoors, submit shop drawings indicating the design of the supports and curbs, the attachments to supports and curbs, and the attachment of the support and curbs to the structure, slab, or grade as required to provide resistance to the wind forces identified in specification section 23 05 48, “Wind, and Vibration Controls”.

E. Field quality control reports.

F. Warranty: Sample of special warranty

G. Closeout Submittals: Provide operating and maintenance data for units for inclusion in the Operating and Maintenance Manuals specified in Division 01

1.3 QUALITY CONTROL

A. Computer room unit internal insulation shall comply with NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems. All insulation shall have a flame spread rating not over 25 and smoke developed rating no higher than 50.

B. All electrical components, devices, and accessories, including motors and starters must be selected and comply with applicable NEMA standards.

C. All factory-furnished electrical components and wiring shall be installed per applicable portions of the latest version of NFPA 70 National Electrical Code.

D. Fabricate and label refrigeration system to comply with ASHRAE 15, Safety Code for Mechanical Refrigeration.

E. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1-2019, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

F. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2019, Section 6 - "Heating, Ventilating, and Air-Conditioning."

G. Certification:

1. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency marked for intended use.

1.4 SYSTEM STARTUP

A. A factory-authorized service representative shall perform startup service.

B. Verify that computer-room air-conditioning units are installed and connected according to manufacturer's written instructions and the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

1.5 WARRANTY

A. Special Warranties – Parts and Labor:

1. Warranty Period for Compressors: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.
2. Warranty Period for Control Boards: Manufacturer's standard, but not less than 3 years from date of Substantial Completion.

1.6 COORDINATION

A. Coordinate layout and installation of computer-room air-conditioning units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

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. Fan Belts: One set for each belt-drive fan.

2. Filters: One set of filters for each unit.

PART 2 – PRODUCTS

2.1 CONSOLE UNITS

A. Manufacturers: Daikin or equal.

B. Description: Split system consisting of evaporator section for floor or wall mounting and remote condensing section.

C. Evaporator Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans, two-speed motor, and cleanable foam filter.

1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2019.

D. Condenser Cabinet: Steel with baked-enamel finish and containing compressor and condenser.

E. Compressor: Hermetic, with resilient suspension system, oil strainer, and internal motor overload protection.

1. Refrigeration Circuit: Crankcase heater, filter/dryer, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
2. Refrigerant: R-410A.

F. Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins. Mount coil assembly over stainless steel insulated drain pan in compliance with ASHRAE 62.1 having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.

G. Air-Cooled Condenser: Integral copper-tube aluminum-fin coil with propeller fan, direct-driven.

H. Control System: Wall mounted remote control with start/stop fan and temperature control.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install computer-room air conditioning units level and plumb, maintaining the manufacturer's recommended clearances.

B. Roof Support: Install and secure roof-mounting units on roof penetrations and flashing with roof construction. Secure units to roof with anchor bolts.

C. Install air-cooled condenser on rubber-in-shear vibration isolators.

3.2 CONNECTIONS

A. Piping installation requirements per manufacturer recommendations for refrigerant line set piping.

B. Install piping adjacent to machine to allow service and maintenance.

C. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioning units and after electrical circuitry has been energized, test for compliance with requirements.
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.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain computer-room air conditioning units.

END OF SECTION 238123

SECTION 238200
CONVECTION UNITS

PART 1 - GENERAL

1.1 RELATED SECTIONS

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

1.2 SUMMARY

A. Section Includes: This section includes furnishing and installing HVAC electric terminal units and specialties as shown on the drawings and as specified hereinafter.

1. Unit heaters
2. Cabinet heaters
3. Convectors

1.3 SUBMITTALS

A. Product Data:

1. Submit product, dimensional, capacity, and performance data for all equipment and control items.
2. Clearly mark or highlight the specific items being furnished. Indicate tag numbers where applicable.

B. Shop Drawings: Submit shop drawings and specific or edited wiring diagrams for all electrically and/or gas-powered equipment.

C. Close-out Submittals: Submit O&M data per Division 01

1.4 QUALITY ASSURANCE

A. All electrically operated equipment shall be UL listed and constructed to NEMA standards.

PART 2 - PRODUCTS

2.1 UNIT HEATERS - ELECTRIC

A. Approved Manufacturers: Berko, Chromalox, Indeeco, Modine, Qmark, and Trane.

B. Provide size, Capacity, and type as scheduled and/or shown on drawings.

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. Comply with UL 2021.

D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless steel machine-staked terminals secured with stainless steel hardware.

E. Integral Power Disconnect: Disconnect all ungrounded conductors in the "off" position.

F. Thermal Overload Protection: Automatic reset thermal overloads shall shut down the element and motor if safe operating temperatures are exceeded.

G. Furnish heavy-gauge steel casing, phosphatized or galvanized for rust and corrosion prevention, and finished with baked-on enamel.

H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

1. Insulation in contact with airstream shall comply with ASTM C 1071, Type I or Type II.

I. Furnish open drip-proof, multi-speed permanent split capacitor motors with permanent lubrication, integral thermal overload protection, and vibration isolation.

J. Provide factory-balanced aluminum propeller fans with steel hubs and fan guard.

K. Furnish double-deflection, individually adjustable discharge louvers.

2.2 CABINET HEATERS - ELECTRIC

A. Acceptable Manufacturers: Berko, Chromalox, Modine, Qmark, and Trane.

B. Units shall be UL listed. Size, capacity, and arrangement shall be as scheduled and/or shown on the drawings.

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. Comply with UL 2021. The unit shall be UL listed for zero clearance to combustible surfaces.

D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless steel machine-staked terminals secured with stainless steel hardware.

E. Integral Power Disconnect: disconnect all ungrounded conductors in the "off" position.

F. Thermal Overload Protection: Automatic reset thermal overloads shall shut down the element and motor if safe operating temperatures are exceeded.

G. Motors: Motors shall be resilient-mounted, permanent-split capacitor or capacitor start, tap wound for 3-speed, with integral thermal overload auto reset protection. Minimum efficiency shall be 85%. Motors shall be permanently lubricated with provision for re-oiling. Shaded pole motors are not acceptable.

H. Cabinets: Cabinets shall be constructed with 16-gauge steel fronts and tops and 18-gauge steel end panels. Fronts and discharge panels shall be insulated with glass fiber or closed cell insulation. Cabinet parts shall be cleaned and phosphatized before painting.

1. The finish shall be standard beige baked-enamel that may be field-painted.
2. Cabinets have an end pocket on both sides. Vertical non-recessed top panels shall be provided with two die-formed flush, hinged access doors.
3. Vertical model front panels shall be one piece, secured to the unit without visible fasteners. Horizontal model bottom panels shall be provided with a continuous hinge along the width of the unit.
4. Front panels for vertical recessed models shall be provided with a hinged front inlet grille, two die-formed flush hinged access doors for fan control, and filter access.

I. Grilles: Surface models with cabinets shall have integrally stamped outlet grilles. Recessed models shall have inlet grilles integrally stamped into the cabinet panel (vertical) or a hinged access panel (horizontal).

PART 3 – EXECUTION

3.1 CABINET HEATERS

A. Install per manufacturer’s recommendations and per schedules and/or drawings.

B. Provide manual air vent, P&T plugs, and shutoff valves for each cabinet heater.

3.2 FILTERS

A. For units with filters, provide one set of filters during construction and start-up and one set of filters at beneficial occupancy.

END OF SECTION 238200

This page intentionally left blank.

SECTION 260010
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.2 REFERENCES

A. The minimum requirements for this work are according to the currently adopted edition of the building codes listed on the plans.

1.3 SUBMITTALS

A. Product Data:

1. Hangers and supports
2. Electricity-metering equipment

B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment, including CT cabinets, conduit and conductor sizes, terminations, and other utility requirements.

C. Coordination Drawings: Plans, sections, and elevations drawn to scale and coordinating installation of equipment, where required by the contract drawings or where site physical conditions limit installation capabilities.

D. Operation and Maintenance Data: For electricity-metering equipment to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a nationally recognized testing agency, and marked for the intended use.

B. All equipment and materials shall be new and unused and shall be in conformance with the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance at no additional cost to the Government.

1.5 SEQUENCING

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installation.

B. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

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

D. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components, prior to commencement of any work.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 08 "Openings."

F. No work shall be concealed until after inspection and approval. If work is concealed without inspection and approval, provide all work required to expose and restore the concealed work in addition to all required modifications.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES FOR ELECTRICAL COMPONENTS

A. Provide hangers and supports to support raceways, fixtures, cabinets, boxes, etc. as manufactured by B-Line, Unistrut, Binkley or Kindorf.

B. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

C. Metal Items for Use Outdoors or in Damp Locations: Steel, hot-dip galvanized after fabrication.

D. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.

1. Channel Thickness: Selected to suit structural loading.
2. Fittings and Accessories: Products of the same manufacturer as channel supports.

F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.

2.2 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

C. Modular Meter Centers: Factory-coordinated assembly of a main meter center circuit-breaker unit with wireways, tenant meter socket modules, and tenant branch circuit breakers arranged in adjacent vertical sections, complete with interconnecting buses.

1. Housing: NEMA 250, Type 3R enclosure.

2.3 CONCRETE EQUIPMENT BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 03, Section "Cast-in-Place Concrete."

2.4 TOUCH-UP PAINT

A. Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Adhere to clearances required by the NEC, NFPA 70. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials

C. Support Clamps for PVC Raceways: Click-type clamp system

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb. design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25% minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 3/8-inch-diameter or larger threaded steel hanger rods, unless otherwise indicated. Trim off threaded rod supports at a maximum length equal to the rod diameter below the bottom nut.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

I. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

J. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

K. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.

2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Threaded studs driven by a powder charge and provided with lock washers in existing concrete are not allowed unless approved by the Architect.
6. Steel: Welded threaded studs or spring-tension clamps on steel. Provide field welding compliant with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25% of its proof-test load.

3.4 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding, cabinets, and empty conduits as required by utility company. Coordinate the exact requirements with utility company.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow the supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated.

3.6 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.7 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work; repair or replace all components found to be damaged or faulty.

B. Test the Government's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kW rating (1.5 kW minimum) to a circuit supplied by the metered feeder.
2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.

3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure 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 the test load connection. Record the test results.
5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of the entire system is verified.

3.8 REFINISHING AND TOUCH-UP PAINTING

A. Refinish and touch-up paint as required. Paint materials and application requirements are specified in Division 09.

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touch-up coating recommended by manufacturer.

3.9 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260010

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

B. Refer to Division 26, Vibration and Seismic Requirements for Electrical Systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field test reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wires and cables according to NEMA WC 26 - *Binational Wire and Cable Packaging Standard*.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Wires and Cables:

a. Alcan Aluminum Corporation; Alcan Cable Div.
b. Alpha Wire
c. American Bare Conductor
d. Cerro Wire LLC
e. Colonial Wire and Cable

f. Encore Wire Corporation
g. General Cable / Carol Brand Wire
h. Leviton Manufacturing Company, Inc.
i. Prysmian Group North America Construction & Infrastructure Group
j. Senator Wire & Cable Company, by Southwire Company
k. Service Wire Co.
l. Southwire Company
m. WESCO International, Inc.

2. Connectors for Wires and Cables:

a. 3M Company; Electrical Products Division
b. ABB - Thomas & Betts
c. AFC Cable Systems
d. AMP Incorporated
e. Emerson - Appleton and O-Z/Gedney Fittings
f. Hubbell Incorporated

2.2 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Conductor Insulation:

1. Type THHN: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

E. Shield:

1. Type TC-ER: Cable designed for use with Variable Frequency Controllers (VFCs), with oversized crosslinked polyethylene insulation, and sunlight- and oil-resistant outer PVC jacket.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: One hole with standard barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

H. VFC Output Circuits: Type XHHW-2 in continuous ferrous metal conduit; type TC-ER cable with shield for non-continuous ferrous metal conduit, or tray installations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. 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.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 00 10 "Common Work Results for Electrical."

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.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

This page intentionally left blank.

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field Test Reports: Submit written test reports to include 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

1) Test wells.
2) Ground rods.

b. Instructions for periodic testing and inspection of grounding features at test wells based on NETA MTS.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association.

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, and marked for intended use. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Grounding Conductors, Cables, Connectors, and Rods:

a. AFL
b. Burndy
c. Copperweld Corp.
d. Eaton
e. Emerson Electric Co. and subsidiaries
f. Galvan Industries, Inc.
g. Harger Lightning & Grounding
h. Hastings Hot Line Tools & Equipment
i. Heary Brothers Lightning Protection Co.
j. Honeywell Salisbury
k. Hubbell Electrical Systems
l. Ideal Industries, Inc.
m. ILSCO
n. Lightning Master Corp.
o. Lyncole XIT Grounding
p. nVent Electrical & Fastening Solutions: CADDY, ERICO, ERIFLEX and LENTON brands
q. Robbins Lightning, Inc

r. Sankosha U.S.A., Inc.
s. Siemens Industry, Inc., Energy Management Division
t. Thomas & Betts Corporation; a member of the ABB Group
u. VFC Lightning Protection Inc.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B3.
2. Assembly of Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Mechanical Type Bolted Connectors: Bolted-pressure-type connectors

C. Compression connectors: Irreversible circumferential compression type connectors

D. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

E. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

F. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

G. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

H. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

I. Conduit Hubs: Mechanical type, terminal with threaded hub.

J. Ground Rod Clamps: Unless indicated otherwise, mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, copper terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Unless indicated otherwise, mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one -piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated bolts.

a. Material: high conductivity copper alloy.
b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

1. Size (Diameter, length): 3/4" x 120"

B. Test Wells: Provide handholes as specified in other Division 26 sections, as well as other specification Divisions.

C. Concrete encased electrode: Per NEC requirements. Encase in conductive cement (Erico GEM or Sankosha San-Earth).

2.5 GROUNDING BUS

A. Provide bare, annealed copper bars of 1/4" x 2" rectangular cross section, with insulators.

1. Electrical room grounding bus minimum of 24 inches in length.
2. Telecommunication equipment room grounding bus minimum of 12 inches) in length.

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. In raceways, use green-colored insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 30 inches below grade

G. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Comply with NFPA 70, , for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. In addition to the ground path provided by the continuously grounded metallic raceway system that encloses the phase and neutral conductors, provide equipment grounding conductors in all

feeders and branch circuits. Where there are parallel feeders installed in more than one raceway, each raceway shall have a green insulated equipment ground conductor.

C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

F. Air Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 volts and more. Bond conductor to each unit and to air duct.

H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, telecommunication room, and central equipment location.

1. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
2. Central Equipment Locations and Telecommunication Equipment Rooms: Terminate grounding conductor on a grounding bus with insulated spacers.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 FENCE GROUNDING

A. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

B. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet .
2. Gates and Other Fence Openings: Ground fence on each side of opening.
3. Bond metal gates to gate posts.
4. Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

3.4 INSTALLATION

A. Ground rods:

1. Drive ground rod until top is 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Triangle Ground 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.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Grounding electrode conductors and bonding jumpers shall be insulated and installed in raceway.

D. Service Equipment: Install insulated equipment grounding conductor from the grounding bus in the switchgear to the wall mounted grounding bus. Terminate grounding conductor on grounding bus with insulated spacers.

E. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

F. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

G. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

H. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Where metallic piping and duct systems are rendered metallically non-continuous by non-conductive couplings, provide bonding jumpers to restore grounding continuity. Use braided-type bonding straps.

I. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

J. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor. Fill with 1-inch maximum size crushed stone or gravel.

K. Concrete-Encased Grounding Electrode: Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. 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 a grounding electrode external to concrete.

3.5 GROUNDING BUS

A. Telecommunication equipment room grounding bus shall be a minimum of 12 inches in length.

3.6 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact. Clean surfaces thoroughly before applying ground lugs or clamps. If surface is coated, the coating must be removed down to the bare metal. After the coating has been removed, apply a noncorrosive approved compound to clean surface and install lugs or clamps. Where galvanizing is removed from metal, it shall be painted or touched up with "Galvanox," or equal.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use bolted- and clamped-type connections between conductors and ground rods.

F. Tighten screws and bolts for grounding and bonding 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.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.7 FIELD QUALITY CONTROL

A. Independent Testing Agency: Contractor to engage a qualified testing agency to perform the tests described below.

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests, by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each 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.

    a. Equipment Rated 500 kVA and Less: 10 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
5. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.8 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 32 "Exterior Improvements." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260526

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

B. Refer to Division 26, Vibration and Seismic Requirements for Electrical Systems.

1.2 SUMMARY

A. This section includes electrical conduits, tubing, surface raceways, and wireways as well as electrical outlet boxes, pull and junction boxes, conduit fittings, and hinged door assemblies.

1.3 REFERENCES

A. The latest edition of the following standards and codes, are the minimum requirements for this work.

ANSI C80.1	Rigid Steel Conduit, Zinc-coated
ANSI C80.6	Intermediate Metal Conduit, Zinc-coated
ANSI C80.3	Electrical Metallic Tubing, Zinc-coated
NEMA FB 1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
NEMA RN 1	Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC2	Rigid Nonmetallic Conduit (Schedule 40 and Schedule 80)
NEMA TC 3	PVC Fittings for Use with Rigid PVC Conduit and Tubing
NEMA TC 14	Reinforced Thermosetting Resin Conduit and Fittings Series
NFPA No. 70	National Electric Code (NEC)

1.4 SUBMITTALS

A. Conduit, Boxes, Wireways, and Auxiliary Gutters: Products by manufacturers meeting the requirements of the referenced standards and any special requirements specified in this section will be acceptable for the project. Provide a letter listing all equipment proposed for installation (including manufacturer and part number, where applicable), and stating that the equipment meets the requirements noted in this section. Where proposed equipment be other than that listed in these specifications, provide manufacturers product data sheets for review.

PART 2 - PRODUCTS

2.1 RACEWAYS AND FITTINGS

A. Metallic Conduit Systems:

1. Electrical Metallic Conduit (EMT): EMT shall comply with UL 797 and ANSI C80.3. EMT shall be zinc-coated steel, galvanized on the outside and coated on the inside with a hard smooth lacquer finish. EMT fittings shall be steel setscrew type with insulated throats. Die cast zinc fittings are prohibited.
2. Flexible Metal Conduit (FMC): FMC shall be single strip, continuous, flexible interlocked double-wrapped steel, zinc-coated inside and out forming smooth internal wiring channel with steel compression fittings and shall comply with UL 1.
3. Intermediate Metal Conduit (IMC): IMC shall be hot-dipped galvanized with a zinc coating and comply with ANSI C80.6. Fittings shall be steel threaded type.
4. Liquid-tight Flexible Metal Conduit (LFMC): FLMC shall comply with UL 360 and be zinc-coated steel the same as FMC except with sunlight-resistant and mineral-oil-resistant plastic jacket. Fittings shall be cast malleable iron or steel body and gland nut, cadmium-plated with one-piece brass grounding bushings threaded to interior of conduit. Provide spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.
5. Rigid Steel Conduit (RSC): RSC shall be heavy wall, hot dipped galvanized steel inside and out with threaded ends, and shall comply with U.S. Standard UL6 and ANSI Standard C80.1. RSC fittings shall be steel, threaded type. Plastic-coated RSC shall be rigid galvanized steel conduit having a 0.030-inch-minimum thick, factory-bonded PVC jacket, using pre-jacketed couplings as manufactured by Pittsburgh Robroy, Plastic Applicator, Occidental, or approved equal.

B. Nonmetallic Conduit Systems:

1. Rigid Nonmetallic Conduit (RNC): RNC shall be polyvinyl chloride (PVC) Schedule 40 or 80 suitable for 90°C. Provide solvent cemented type fittings matched to conduit type and material.
2. Liquidtight Flexible Nonmetallic Conduit (LFNC): LFNC shall comply with UL 1660.
4. Nonmetallic Conduit System manufacturers shall have a current Certificate, issued by an independent and accredited company, of compliance with an ISO 9001 Quality Management System.

C. Surface metal raceway shall be Wiremold, MonoSystems, Inc., or Walker-Parkersburg. Raceways, fittings, and components shall be of one manufacturer and designed for use together.

D. Metal Wireways: Wireways shall be hinged cover or screw cover complete with all necessary manufactured fittings which shall be of one manufacturer.

1. Material: Sheet metal sized and shaped as indicated.
2. 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. Provide wire retainers at not greater than 12 inches on center.
3. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
4. Wireway Covers: Hinged type
5. Finish: Manufacturer's standard enamel finish

E. Nonmetallic Wireways:

1. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover, and mechanically coupled connections using plastic fasteners.
2. 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.
3. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

F. Raceway Fittings: Specifically designed for the raceway type with which used.

G. Bushings: For rigid steel conduit larger than 1/2-inch size, provide insulated type bushings, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system. Grounding bushings shall be locking type and shall be provided with a feed-through compression lug for securing the ground cables. Unions shall be electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal.

H. Expansion Fittings: Each conduit that is buried in or secured to the building's construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings shall be rigid steel hot-dipped galvanized or malleable iron with factory-installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25 feet or less, and the long type in runs 26 to 80 feet. The short type shall be a one-piece, coupling with O ring, providing 2 inches of total movement range in 1/2-inch to 2-inch conduit sizes. The long type shall be a two-piece barrel and piston joint, providing 6 inches of the total movement range in 1/2-inch through 6-inch conduit sizes. Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.

I. Sealing Fittings: Provide threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

2.2 OUTLET, JUNCTION, AND PULL BOXES

A. Acceptable Manufacturers:

1. Boxes and Cabinets: Bowers, Raco, Steel City, Appleton, Hoffman, or approved equal.
2. Floor Boxes: Walker; Hubbell; Raceway Components, Inc.; MonoSystems, Inc.; or approved equal.

B. Outlet, Junction, and Pull Boxes:

1. Cast Type Boxes: Cast type boxes shall be ferrous alloy and have gasketed cast covers and inside threaded hubs with adapters as necessary. Cast-metal boxes shall comply with NEMA FB 1, Type FD.
2. Galvanized Pressed Steel Type Boxes: Boxes shall be pressed steel, galvanized or cadmium-plated, 4-inch minimum octagonal or square with galvanized cover or extension ring as required. Knockout type shall be used with knockouts removed only where necessary to accommodate the conduit entering. Boxes shall comply with NEMA OS 1. Provide a grounding terminal in each box containing a green equipment ground conductor, or serving motors, lighting fixtures, or receptacles. Grounding terminal shall be green-colored washer-in-head machine screw or grounding bushing.
3. Large Sheet Steel Boxes:

    a. 12-Gaugesheet steel for boxes with maximum side less than 40 inches, and maximum area not exceeding 1,000 square inches; riveted or welded 3/4-inch flanges at exterior corners.
    b. Covers:

        1) Same gauge steel as box. Provide lifting handles on covers with any dimension larger than 36 inches
        2) Subdivided single covers so no section of cover exceeds 50 pounds
        3) Machine bolts or machine screws threaded into tapped holes.

    c. Paint: Rust inhibiting primer, ANSI 61 gray enamel finish coat.

4. Floor Boxes and Fittings:

    a. General:

        1) Provide flush floor boxes and fittings of the types, ratings, and configurations as shown on the Drawings.
        2) Floor boxes and fittings shall be suitable for the fire rating and thickness of the floor.

3) Combination power/telecom outlets shall have barrier to separate power and telecom wiring.
4) Provide carpet flange to match box cover, where carpet is installed; finish as selected by the Architect.

b. Recessed Flush Floor Box:

1) Cast-iron box, multiple gang, shallow depth, brass carpet flange, and coverplates. Walkerbox or equal by other approved manufacturer.
2) Receptacles shall be 125V, 15A unless otherwise noted.
3) Combination Duplex Receptacle/Telecom Outlet: Provide indicated power outlets with 828R coverplate and 829S telecom coverplate.
4) Telecom Outlet: Provide 829S coverplate.
5) Power Connection to Electrified Furniture System: Walkertap RC 900 FF Series Poke-Thru with blank plate service fitting with factory cut hole for connection of furniture system wiring whip.
6) Telecom Connection to Electrified Furniture System: Walkertap RC 900 FF.

PART 3 - EXECUTION

3.1 GENERAL

A. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

B. Consult all other drawings. Verify all scales and report any dimensional discrepancies or other conflicts to Architect before submitting bid.

C. All home runs to panelboards are intended to be started from outlet nearest panel and continuing in general direction of that panel. Continue such circuits to panel as though routes were completely indicated. Terminate homeruns of signal, alarm, and communications systems in a similar manner.

D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Architect, and conform to all structural requirements when cutting or boring structure is necessary and permitted.

E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc. required for equipment specified under this section.

3.2 SLEEVES

A. Provide sleeves accurately set in place in forms for new concrete walls, floor slabs and partitions for passage of raceways. Waterproof all sleeved raceways.

B. The electrical contractor shall be present during the pouring of concrete to make sure the location of sleeves is not disturbed during the pour.

C. All sleeves through concrete floors shall be pipe sleeves with the top of sleeves a minimum of 1/2 inch above finished floor surfaces. Do not utilize more than one sleeve per pipe. Blockouts for multiple pipes or individual pipes will not be allowed except where approved by the structural engineer/Architect.

D. In cases where cast-in-place openings are not possible, appropriate size holes shall be bored through the concrete to accommodate the conduit passage. The size and location of the holes shall not impair the structure's integrity. After completion, grout or caulk around conduit and finish to match existing surroundings. Cut all openings for which sleeves are omitted with rotary type drill, or other method as approved by the Architect. Holes cut with pneumatic hammer will not be accepted.

3.3 RACEWAYS

A. Provide raceways for all power and special systems as indicated. Emergency system wiring shall be kept independent of other wiring systems. Provide insulated equipment grounding conductor in all raceways. Minimum conduit size shall be 3/4 inch. Wiring of each type and system shall be installed in separate raceways.

B. Install telephone and signal system raceways, 2-inch trade size and smaller, in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.

C. Locate raceways so that the integrity of structural members is not affected and they do not conflict with the services of other trades. Draw up couplings and fittings full and tight. Protect threads from corrosion after installation with zinc chromate or equivalent protection.

D. Install power raceways a minimum of 24 inches from telecommunications raceways, cross at 90° angle.

E. Protect all non-PVC coated metallic raceway in earth or fill from corrosion with two coats of corrosion resistant paint or tape wrap.

F. Elbows for conduit installed below grade or embedded within floor slabs shall be RTRC or rigid steel conduit with factory PVC coating or two coats of corrosion resistant paint or tape wrap. Tie the embedded raceways securely in place prior to concrete placement.

G. Raceways and elbows that stub-up above the slab shall extend a minimum of 4 inches above the finished slab or housekeeping pad to the first connector. Stub-ups shall be PVC coated rigid steel; RTRC and PVC shall not be used. Install capped bushings on conduit stub-ups.

H. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb. (90-kg) tensile strength. Leave at least 12 inches of slack at each end of the pull wire. Tag both ends noting destination.

I. Use temporary raceway caps to prevent foreign matter from entering conduits.

J. Make all bends using an approved bending tool. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated. Cut all conduits square and ream all cuts to remove burrs. Exercise all necessary precautions during the construction period to prevent entry or accumulation of moisture, dust, concrete, and all foreign matter into the raceway system. Pull a mandrel through each raceway to ensure that the raceway interior is clean and dry prior to pulling conductors or cable.

K. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.

L. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72 inch flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

M. Above grade - defined as areas above finished grade for a building exterior and above top surface of any slabs (or other concrete work on grade) for a building interior. Installation of and materials for above-grade raceways shall conform with the following:

1. Install all raceways concealed within finished walls, ceilings, and floors except at surface cabinets, for motor and equipment connections, and in building service equipment rooms unless otherwise indicated. Route exposed raceways and raceways above suspended ceilings parallel or perpendicular to building lines with right angle turns and symmetrical bends. Raceways below or within floor slabs shall be run in a direct line, and where possible, with long sweep bends and offsets.
2. Install raceways a minimum of 6 inches away from parallel runs of flues and steam pipes or other heated lines. Locate horizontal raceway runs above water and steam piping.
3. Provide for waterproofing of all raceways, outlets, fittings, etc. which penetrate exterior walls or the roof to preserve the weatherproof integrity of the building. Provide pockets for waterflashing and counterflashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. which penetrate roof. Wherever conduits penetrate concrete walls to outdoors, the Contractor shall provide a watertight seal as

manufactured by O.Z. Gedney Company, Type CSMC; Thunderline Corporation, Link Seal, or equal.

4. Raceways between cabinets, fittings, or boxes shall not exceed 200 feet for straight runs or 100 feet for runs with the maximum number of bends.
5. Provide one empty 3/4-inch conduit for each set of three spare circuit breakers or spaces in flush-mounted panelboards into the overhead accessible ceiling space.
6. Raceways Embedded in Floor Slabs:

    a. Raceways shall not be installed in slab .
    b. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Raceways shall not interfere with placement of floor slab reinforcement components.
    c. Install raceways between the upper and the lower layers of reinforcing steel.
    d. Space raceways not less than 8 inches on centers except where they converge at panels or junction boxes.
    e. Raceways running parallel to slab supports, such as beams, columns and structural walls, shall be installed not less than 12 inches from such supporting elements.
    f. Rigid steel conduit, or rigid nonmetallic conduit may be embedded in concrete providing the outside diameter does not exceed one-third the thickness of the concrete slab, wall, or beam and it is located entirely within the center third of the member with at least 1 inch concrete cover. Space the raceways laterally to prevent voids in the concrete.

7. Raceways Above Suspended Ceilings:

    a. Raceways shall not be supported from ceiling support wires. Provide independent support of raceways.
    b. Install conduit 1 foot minimum above top of ceiling.

8. Rigid metallic steel conduit shall be installed in the following above-grade areas:

    a. Where exposed to mechanical injury.
    b. Where specifically required by the National Electrical Code.

9. Electrical Metallic Tubing (EMT): May be installed in dry areas only in:

    a. Concealed locations in furred or masonry walls or ceilings.
    b. Embedded in poured insulating fills.
    c. Exposed areas at least 8 feet above floor.

10. Flexible metal conduit shall be provided in sufficient lengths for makeup of motor, transformer or equipment, and/or raceway connections where isolation of sound and vibration transmission is required. Provide liquid-tight flexible conduit in exterior, wet

or damp locations and for connections to wet-pipe mechanical systems. Flexible metal conduit shall contain a separate equipment grounding conductor, sized per NEC requirements.

11. Flexible metallic 3/8-inch fixture whip connections to recessed lighting fixtures shall not exceed 6 feet in length.
12. Surface raceways, where indicated on drawings, shall be metal and of a size approved for number and size of wires to be installed and shall be installed in a neat, workmanlike manner, with runs parallel or perpendicular to walls and partitions. Raceways, elbows, fittings, outlets and devices shall be of same manufacturer, and designed for use together.
13. Wireways, where indicated, shall be complete with elbows, tees, connectors, adaptors, etc., with all parts factory fabricated and of same manufacturer. Install wireways above suspended ceilings such that cover will hinge upward from side. Provide 12 inches clear from wireway cover when in open position.
14. Fittings: Use approved type couplings and connectors in all conduit runs, and make all joints tight. Provide insulated bushings or rain-tight connections with insulated throats for all terminations in pipe sizes 1-1/4 inch and larger. Provide waterproof fittings for all runs in wet locations, such as exposed to weather, buried in slabs, etc. Provide raceway expansion joints with necessary bonding conductor at building expansion joints, between structures, and where required to compensate for raceway or building thermal expansion and contraction.

N. Below Grade: Defined as area below finished grade for a building exterior and below bottom floor slab for a building interior. Installation of and materials for below-grade raceways shall conform with the following:

1. Below-grade raceways shall project 4 inch minimum above floor or equipment foundation.
2. Install exterior underground conduits 30 inch minimum below finished grade unless shown otherwise on the drawings.
3. Do not penetrate waterproof membranes unless proper seals are provided.
4. Conduits below building slab shall be 12 inch minimum below bottom of concrete.
5. Make all penetrations through concrete with plastic-coated rigid steel conduit and sleeves:

    a. At foundation and slab penetrations from below grade to interior, provide sleeves and link-seal for watertight seal; extend plastic-coated rigid steel conduit 5 feet beyond foundation wall.
    b. At foundation penetrations from below grade to below grade, provide sleeves for watertight seal; extend plastic-coated rigid steel conduit 5 feet beyond both sides of foundation wall.

6. Non-encased Raceways: For installation below slabs on grade or in earth or gravel, unless specifically noted on drawings for concrete encasement, provide either of the following raceway systems specified in sub-paragraphs a., b. or c.

a. Rigid, heavy-wall, Schedule 40 or 80, polyvinyl chloride PVC plastic conduit, suitable for direct burial. If schedule 80 PVC is used, conductor fill recalculation is required and the raceway re-sized if necessary; in all recalculation situations the raceway size shall not be reduced. All offsets and 90-degree ells shall be plastic-coated rigid steel conduit or RTRC. Provide continuous ground wire for all non-metallic conduits.
b. Rigid steel conduit that is not completely encased in concrete but is in contact with ground or on a vapor barrier shall be wrapped with Scotchrap 51 half-lapped, or shall be plastic-coated rigid steel conduit. Other PVC or Phenolic-resin-epoxy coating material which is equally flexible and chemically resistant may be used providing approval by the Engineer is obtained prior to installation. Provide pre-jacketed couplings to provide a substantially watertight jacketing system.
c. Cut rigid steel conduit ends square, thread and ream to remove burrs and sharp edges. Make joints with standard couplings - no running threads permitted. Paint threads with "LPS Zinc Rich" where installed below grade or where threads are not galvanized.
d. All underground conduits and ducts 2 inches and larger shall be proven clear by pulling through a ball mandrel (diameter approximately 85% of conduit inside diameter) followed by close fitting wire brush and wad of felt or similar material. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. Clean empty raceways similarly. Clear or replace any raceway which rejects ball mandrel.
e. Provide seal-off fittings where conduits enter or leave areas of widely different temperature and/or humidity.
f. RTRC conduit shall be supplied with a bonded coupling or an integral wound bell on one end and a machined spigot on the other end. A two part adhesive, epoxy resin system, designed to permanently bond fittings and joints of conduit shall be properly mixed and applied to the spigot end before joining the conduits together. The adhesive shall be suitable for the ambient temperatures of the final installation. The adhesive shall be supplied from the same manufacturer of RTRC conduit and fittings.

7. Non-Metallic Raceway Installations:

a. In locations permitted by the NEC, provide either PVC or RTRC conduit systems for non-metallic raceway installations.
b. Joints shall be made using the material recommended by the raceway manufacturer. Components shall be cleaned prior to assembly.
c. Raceway cutoffs shall be square and shall not deform conduit. Ream rough surfaces.
d. Provide male box adapters to terminate raceways.
e. Where separable terminations are required, provide threaded adapters with locknuts or bushings. Provide "O" rings for watertight installations.

f. Bends shall be made by manufacturer's recommended methods that do not deform or damage the conduit.
g. Provide expansion fittings where required.
h. Raceway supports shall be installed to allow the non-metallic conduit to slide through the supports.
i. Non-metallic raceway is not permitted within the building.

3.4 OUTLET, JUNCTION, AND PULL BOXES

A. Except where otherwise indicated, provide galvanized or zinc-coated, pressed steel outlet boxes for all locations. Provide cast metal boxes where required by the NEC. Pressed steel boxes are to be minimum 4-inch square or octagonal, and of depth as required. Provide plaster or tile rings for all flush outlets installed where wood, drywall, tile, plaster, etc. types of finishes are applied. All outlets for exterior application shall be cast, weatherproof type, with gasket and cast coverplate. Tile boxes of extra depth may be used for interior, dry applications where masonry block or brick walls constitute the finished wall surface. Boxes installed in masonry walls shall be cast metal, installed as part of the original wall construction to correspond with consistent brick or block course (where new), and coordinated with both the masonry subcontractor and the architect for location. In any event, provide outlet boxes of proper type and design for the particular fixture or device to be installed. Boxes shall be installed such that they are accessible and with adequate working clearance. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc. with Architect and/or Engineer.

B. Equip light fixture outlet boxes with 3/8-inch no-bolt fixture studs. Provide a minimum 4-inch octagon box. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4-inch square box with tile ring in masonry walls which will not be plastered or furred, or where "drywall" type materials are applied.

C. Except as otherwise noted, locate outlet boxes as follows: Dimensions given are from finished floor to center line of outlets. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course.

1. Wall switch outlets ..... 44 inches
2. Convenience outlets, long axis vertical with grounding pole on bottom ..... 18 inches
3. Phone and data outlets ..... 18 inches
4. Wall-mounted phone outlet ..... 44 inches

D. Provide outlet boxes of proper type and design for the particular fixture or device to be installed. Boxes shall be installed such that they are accessible and with adequate working clearance. In stud walls, provide box supports that span two structural framing members to rigidly support boxes. Far side box supports that rely on the gypsum board for rigid support are not acceptable.

E. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes over 12 inches in any dimension shall be fabricated from sheet steel, sized according to code, and have screw-on covers. All junction boxes shall be accessible.

F. Back-to-back outlets in the same wall or through-wall type boxes are not permitted. Provide 8-inch (minimum) long nipple to offset all outlets shown on opposite sides of a common wall to minimize sound transmission.

G. Surface-mounted devices are to be mounted in cast-type boxes with gasketed covers.

H. Floor Outlets: Provide surface- or flush-floor outlets in locations indicated on drawings. Provide service top in color as directed by Architect. Provide complete complement of parts needed for finished installation including floor box, carpet flange, fittings, and device covers. Set floor boxes level and trim after installation to fit flush to finished floor surface.

I. Removable covers must be accessible at all times. Mount per "Outlets" Section.

J. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with Architectural Division.

K. All pull boxes shall be set rigidly in place with their front set straight and plumb.

L. Install device plates in full contact with wall surface. Plates shall not project out from the wall.

M. Mark junction box covers in ceiling spaces or unfinished areas with permanent stencil identification of panelboard and circuit numbers of wiring contained within.

END OF SECTION 260533

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on orange field.
2. Legend: Indicates voltage.

B. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

C. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide x 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend indicating type of underground line.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, a minimum of 1/16-inchthick for signs up to 20 square inches and 1/8-inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-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°F
4. Color: According to color-coding

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime surfaces using type of primer specified for surface.
3. Apply one intermediate and one finish coat of enamel.

E. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

F. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover
2. Concealed Boxes: Plasticized card-stock tags
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent

G. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

H. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.

1. Color-code 208/120-volt system as follows:

a. Phase A: Black
b. Phase B: Red
c. Phase C: Blue
d. Neutral: White
e. Ground: Green

2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

a. Colored,3.1. pressure-sensitive plastic tape in half-lapped turns for a 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. Use 1-inch-wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.

b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3-inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

I. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inchsteel letter and number stamping or embossing with legend corresponding to indicated circuit designations
2. Tag Fasteners: Nylon cable ties
3. Band Fasteners: Integral ears

J. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

K. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

L. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1-1/2-inch -high label; where two lines of text are required, use labels 2 inches high. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

1. Panelboards, electrical cabinets, and enclosures
2. Access doors and panels for concealed electrical items
3. Electrical switchgear and switchboards
4. Disconnect switches
5. Enclosed circuit breakers
6. Motor starters
8. Contactors
9. Dimmers

10. Control devices

END OF SECTION 260553

This page intentionally left blank.

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes commissioning process requirements for electrical service, distribution, lighting and lighting controls and equipment.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For pre-functional checklists, comply with requirements in various Division 26 Sections specifying electrical systems, system components, equipment, and products.

1.2 DEFINITIONS

A. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. Standby Power Systems: A power system that a facility transitions to in the absence of Normal power. This power includes all systems classified as "optional" or "emergency," or "legally required."

E. Low Voltage: 600 V and below.

F. Medium Voltage: 601 V and above.

G. Normal Power Systems: A power system that provides primary power to a facility.

H. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."

I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 SYSTEMS TO BE COMMISSIONED

1. Lighting and Lighting Controls

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For electrical testing technician.

B. Submittals: Submittals associated with commissioned systems.

C. Pre-Functional Checklists: Filled out pre-functional checklists. Pre-functional checklists are created by CxA for Contractor review.

D. Functional Performance Tests: Include the following and comply with requirements in Section 019113 "General Commissioning Requirements" for Functional Performance Tests:

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electrical systems and components to include operation and maintenance manuals linked in Revit model.

B. Record of Training of Government’s operation and maintenance personnel of commissioned systems.

1.6 QUALITY ASSURANCE

A. Electrical Testing Technician Qualifications: Technicians to fill out electrical Pre-functional Checklists and perform Functional Performance Test verification test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in electrical systems, or similar field. Degree may be offset by three years' experience as an apprentice or a journey-level electrician. Generally, required knowledge includes electrical and HVAC&R concepts, building operations, and application and use of tools and instrumentation to measure performance of electrical equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform electrical Cx work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

    a. Equipment/instrument identification number.
    b. Planned Cx application or use.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

    a. Capable of testing and measuring performance within the specified acceptance criteria.
    b. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
    c. Be maintained in good repair and operating condition throughout duration of use on Project.
    d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

C. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

    a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

        1) Instrument or tool identification number.
        2) Equipment schedule designation of equipment for which the instrument or tool is required.
        3) Manufacturer, make, model, and serial number.
        4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

    b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 MEETINGS

A. Meetings held as part of the commissioning process will include electrical systems as necessary.

3.2 SUBMITTALS

A. The CxA will provide appropriate the general contractor with a list of electrical submittals to be reviewed.

B. The Contracting Officer will facilitate the distribution of electrical submittals to the CxA.

C. The CxA will review electrical submittals within 10 business days.

3.3 PRE-FUNCTIONAL CHECKLISTS

A. Review and provide written comments on draft Pre-Functional Checklists. CxA will create required draft Pre-Functional Checklists and provide them to Contractor.

B. Return draft pre-functional checklist review comments within 10 business days of receipt.

C. When review comments have been resolved, the CxA will provide final Pre-Functional Checklists.

D. Mechanical, Electrical, and Controls contractors will fill out their respective sections of the pre-functional checklists and note any outstanding deficiencies.

E. Comply with Pre-Functional Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying electrical systems and equipment.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. Prior to functional testing, checks for the following conditions will be made:
   1. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved Shop Drawings and submittals.
   2. Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and

approved Shop Drawings and submittals, and that pretest set points have been recorded.

3. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
4. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
5. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

B. Perform tests using design conditions, whenever possible.
   1. Functional Performance Test procedures may direct that set points be altered when simulating conditions is impractical.
   2. Functional Performance Test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

C. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to the Contracting Officer. After deficiencies are resolved, reschedule tests.

D. Functional Performance Tests for Electrical Systems
   1. Verification of Control and Instrumentation:
   2. Prerequisites: Acceptance of results for Pre-functional checklists.
   3. Test Purpose: Verify operation of control and monitoring systems for Normal power systems.
   4. Test Conditions:
      a. Energize components of Normal power system.
      b. Test operation of equipment.
   5. Acceptance Criteria: Operation of equipment according to OPR and BOD.

END OF SECTION 260800

This page intentionally left blank

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 specification sections. Any submitted device that differs in any manner from that specified must be marked "exception." Clearly indicate exact differences and include all manufacturers' data as indicated.

B. Product Data: including device operation, warranty period, wiring diagram(s), dimensions, materials, and finishes.

C. Samples: Where specifically required in the specifications, submit samples for devices and device plates for color selection and evaluation of technical features.

D. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: Manufacturers indicated are used to establish a minimum acceptable standard of quality. Similar products by comparable manufacturers may be considered.

1. Outdoor Photoelectric Controls:

a. Lutron
b. Intermatic

c. TORK

2. Load Control Modules for Wireless Sensors and Control Stations:

   a. Lutron

3. Wireless Sensors:

   a. Lutron

4. Wireless Control Stations:

   a. Lutron

5. Modular Dimming Controls

   a. Lutron

6. Lighting Control Modules

   a. Lutron

7. Switch Box Occupancy Sensors

   a. Lutron
   b. Sensor Switch
   c. Wattstopper Inc.

8. Switch Box 0-10V Dimming Occupancy Sensors

   a. Lutron

9. Emergency Shunt Relays:

   a. Hubbell Building Automation
   b. Philips Bodine
   c. Sensor Switch
   d. Watt-Stopper Inc.

2.2 OUTDOOR PHOTOELECTRIC CONTROL SWITCH

A. Description: Photocell with single pole dry contacts rated for 1800-VA tungsten, or 1000-VA ballast at 120V or or 2300-VA ballast at 277V, or to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.0 to 5 fc ON, 3.0 to 15 fc OFF, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: 15-second minimum, to prevent false operation.
4. Warranty: 5 years.

2.3 LOAD CONTROL MODULES FOR WIRELESS SENSORS AND CONTROL STATIONS

A. Provide wireless load control module as indicated or as required to control the loads as indicated.

1. Dimming Modules:

a. Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.
b. Configurable high- and low-end trim.
c. Relay: Rated for 0-10V ballasts, LED drivers, or fixture that conform with NEMA410.

2. Relay Modules:

a. Rate Life of Relay: Typical of 1,000,000 cycles at fully rated 16A for all lighting loads.
b. Fully rated output continuously duty for inductive, capacitive, and resistive loads.

2.4 WIRELESS SENSORS

A. General Requirements:

1. Operational life of 10 years with the need to replace batteries when installed per manufacturer's instructions.
2. Communicates directly to compatible RF receiving devices through use of radio frequency communications link.
3. Does not require external power pack, power wiring, or communications wiring.
4. Capable of being placed in test mode to verify correct operation from the face of the unit.

B. Wireless Occupancy/Vacancy Sensors:

1. General Requirements:

a. Provides a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
b. Sensing Mechanism: Passive infrared coupled with technology for sensing fine motions. Signal processing technology detects fine motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.

c. Provide option, readily accessible, user-adjustable control for timeout, automatic/manual-on, and sensitivity.
d. Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
e. Capable of turning dimmer's lighting load on to an optional locked preset level selectable by the user. Locked preset range to be selectable on the dimmer from 1 percent to 100 percent.
f. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
g. Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be designed for easy, damage free removal.

2. Ceiling Mounted Sensors:

a. Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
b. Provide recessed mounting bracket compatible with drywall and compressed fiber ceilings.

3. Wall Mounted Sensors: Provide wall or corner mounting brackets compatible with drywall and plaster walls.

C. Wireless Daylight Sensors:

1. Open-loop basis for daylight sensing control scheme.
2. Stable output over temperature from 32 degree F (0 degrees C) to 140 degrees F (40 degrees C).
3. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
4. Provide linear response from 2 to 150 foot candles.
5. Mounting:

a. Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
b. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
c. Provide temporary mounting means for drop ceilings to allow users to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting methods to be designed for easy, damage-free removal.

2.5 WIRELESS CONTROL STATIONS

A. Communicates directly to compatible RF receiving devices through the use of radio frequency communications link.

B. Does not require external power packs, power, or communications wiring.

C. Allows for each reprogramming without replace unit.

D. Button Programming:

1. Single action.
2. Toggle action.

E. Includes LED to indicate button press or programming mode status.

F. Mounting

1. Capable of being mounted directly to wall under faceplate.
2. Faceplates: Provide concealed mounting hardware.

G. Power: Battery-operated with minimum of 10 year battery life (3-year battery life for night light models).

1. Warranty: 5 years.

2.6 MODULAR DIMMING CONTROLS

A. General Requirements: Provide main unit with configuration and quantity of zones as indicated or as required to control the loads indicated.

1. Integrated Wireless Capability:

a. Provide wireless communication inputs for:

1) Occupancy Sensors.
2) Daylight Sensors.
3) Wireless controller.

b. RF Range: 30 feet between sensor and compatible RF receiving device(s).
c. RF Frequency: 434 MHz; operate in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.

2. Preset Lighting Control with Zone Override:

a. Intensity for each zone indicated by means of one illuminated bar graph per zone.
b. User-programmable zone and scene names.
c. Utilize air gap off to disconnect the load from line supply.
d. Astronomical time clock and programmer interface provides access to:

1) Scene selections.
2) Fade zone to a level.
3) Fine-tuning of preset leves with scene raise/lower.
4) Lock out scenes and zones.

5) Fine-tuning of light levels with individual zone raise/lower.
6) Terminal block for wired infrared signal input.
7) Enable/disable wall station.

e. Lighting intensity with real time energy savings by digital display.
f. Fade time indicated by digital display for current scene while fading.
g. Integral wide angle infrared receiver.
h. For temporary local overrides, individual raise/lower button to allow zones to be adjusted without altering scene values stored in memory.

2.7 LIGHTING CONTROL MODULES

A. General Requirements:

1. Listed to UL 508 as industrial control equipment.
2. Delivered and installed as a listed factory-assembled panel.
3. Passively cooled via free-convection, unaided by fans or other means.
4. Mounting: Surface.
5. Supplies power for control link for keypads and control interfaces.
6. Distributes sensor data among multiple lighting control modules.

B. Switching Lighting Control Modules:

1. Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
2. Load switched in a manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
3. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
4. Module to integrate up to four individually controlled zones.
5. Utilize air gap off, activated when user selects “off” at any control to disconnect the load from line supply.

C. 0-10V Lighting Control Modules:

1. Single low voltage dimming module; capable of control following light sources:

a. 0-10V analog voltage signal.

1) Provide Class 2 isolated 0-10V output signal conforming to IEC 90929.
2) Sink current per IEC 60929.

b. 10-0V analog voltage signal.

1) Provide Class 2 isolated 0-10V output signal conforming to IEC 90929.
2) Sink current per IEC 60929.

2. Switching:

a. Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
b. Load switched in a manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
d. Module to integrate up to four individually controlled zones.
e. Utilize air gap off, activated when user selects “off” at any control to disconnect the load from line supply.

2.8 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

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. Operating Ambient Conditions: Dry interior conditions, 32 to 120°F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277V, and 1500W incandescent.
4. Standard Range: 180-degree field of view, with a minimum coverage area capable of sensing occupancy in a room up to 15 feet x 15 feet.
5. Sensing Technology: Provide PIR or dual-technology sensors to meet space sensing requirements.
6. Switch Type: selectable for manual ‘on’ or automatic ‘on’ at unit.
7. Voltage: match circuit voltage.
8. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 2 to 200 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
9. Concealed "off" time-delay selection from 30 seconds to 30 minutes with test mode.
10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
11. Warranty: 5 years.

2.9 SWITCHBOX-MOUNTED 0-10V DIMMING OCCUPANCY SENSORS

A. General Requirements:

1. Compatible with sourcing electronic 0-10V ballast/drivers, as per IEC 60929 Annex E.2 0-10V protocol.
2. Adjustable sensitivity (high, medium, low, and minimum presets).
3. Adjustable high/low end trims.
4. Selectable dimming curve (linear or square law).
5. Dimming Features: Locked preset, fade-to-on, fade-to-off.

6. Turns off lighting after reasonable and adjustable time delay once the last per to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
7. Selectable option to enable low light feature (automatic-on when ambient light is below threshold). Ambient light threshold to be selectable as either adaptive utilizing occupant feedback or as fixed (high, medium, low, and minimum presets).
8. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or vacancy sensor (manual-on and automatic-off).

2.10 EMERGENCY SHUNT RELAY

A. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: provide to match voltage of lighting circuit.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90 to 100% coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors.

C. Arrange a pre-installation meeting with the manufacturer's factory-authorized representative, at the Government's facility, to verify placement of sensors and installation criteria.

D. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, and HVAC equipment.

E. Set time delay for all occupancy sensors to maximum 30 minutes.

F. Set Dual-Technology occupancy sensors to be activated by either infrared or ultrasonic technologies.

G. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26, Section 26 05 19, "Low-Voltage Electrical Power Conductors and Cables," for low-voltage connections.

B. Wiring Method: Install all wiring in raceway as specified in Division 26, Section 26 05 33, "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Comply with NECA

1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions. Bundle, train, and support wiring in enclosures

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.

F. Ground equipment Connections

G. 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.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26, Section 26 05 53, "Identification for Electrical Systems."

B. Label time switches and contactors with a unique designation. Identify controlled circuits in lighting contactors.

3.5 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. 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.

C. Lighting control devices will be considered defective and shall be replaced if they do not pass tests and inspections.

D. Prepare test and inspection reports and submit to the Government/Architect for review.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify that lighting is controlled to suit the Government operations. Adjust sensitivity and time delay to suit the Government's operations.
2. For daylighting controls, adjust set points and deadband controls to suit the Government's operations.

3.7 DEMONSTRATION AND TRAINING

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943 "Relay-Based Lighting Controls".

B. Engage a factory authorized service representative to train the Government's maintenance personnel as specified below:

1. Train the Government's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of three hours' training.
2. Training Aid: Use the approved final version of maintenance manuals as a training aid.

C. Schedule training with the Government, through the Architect, with at least two weeks' advance notice

END OF SECTION 260923

SECTION 262413
SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of switchboards and overcurrent protective devices.
e. Utility company's metering provisions with indication of approval by utility company.
h. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports and include 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.

F. Maintenance Data: For switchboards and components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Division 01, 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 curves, including selectable ranges for each type of overcurrent protective device.

G. Short Circuit:

1. Prepare a short circuit study based on the actual overcurrent protection devices proposed for use. Provide overcurrent protective devices of suitable type and rating to meet or exceed the available short circuit currents indicated in the short circuit study. The study shall be prepared by an electrical engineer licensed in the State of the project.
2. The study shall be submitted with the distribution equipment submittal and shall indicate where device substitutions are being made in order to achieve adequate interrupting capacity ratings for each piece of equipment.
3. The study shall include recommended settings of adjustable overcurrent and ground fault settings.
5. Obtain the actual available short circuit current at utility company transformer secondary from the utility company.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency that is a member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or 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, and marked for intended use.

C. Comply with the following standards:

1. NFPA 70
2. Switchboards:

a. NEMA PB-2
b. UL 891
c. UL service entrance label

3. Overcurrent Protection Devices:

   a. Circuit Breakers: NEMA AB-1, Federal Specification W-C-375 B/GEN, UL489
   b. Switch and Fuse: UL977

4. Testing: NETA
5. Utility company requirements

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path.

B. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250-W per section) to prevent condensation.

C. Handle switchboards according to NEMA PB 2.1.

1.5 PROJECT CONDITIONS

C. Environmental Limitations: Rate equipment for continuous operation under the following, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104°F
2. Altitude: Not exceeding 6600 feet

1.6 COORDINATION

A. Coordinate layout and installation of switchboards 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.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03, Section "Cast-in-Place Concrete."

1.7 EXTRA MATERIALS

A. Spare Indicating Lights: Two of each type installed.

PART 2 - PRODUCT

2.1 MANUFACTURERS

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. Eaton Corp.
2. General Electric Co.; Electrical Distribution & Control Div.
3. Square D Co.; Schneider Electric USA

2.2 MANUFACTURED UNITS

A. Front-Connected, Front-Accessible Switchboard: Panel-mounted main device, panel-mounted branches, and sections rear aligned.

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.

B. Nominal System Voltage: 208Y/120V

C. Main-Bus Continuous: See drawings.

2.3 FABRICATION AND FEATURES

A. Switchboards shall be completely self-supporting structures of the required number of vertical sections bolted together to form a single metal enclosed switchboard. Sides, top, and rear covers shall be code gauge steel, bolted to the switchboard structure. The frame structure members shall be die-formed, 12-gauge steel bolted together and reinforced at corners with rugged gussets internal to the switchboard members.

B. Switchboards shall be provided with adequate lifting means, and be capable of being rolled or moved into position and bolted directly to the floor without the use of floor sills.

C. Switchboard sections shall be aligned on top, 90 inches high, unless lower height is required due to space limitations.

D. Enclosure: Steel: NEMA 250, Type 3R.

E. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, including undersurfaces treated with corrosion-resistant undercoating.

F. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
2. Space-Heater Power Source: Transformer factory installed in switchboard.

G. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.

H. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

J. Pull Box on Top of Switchboard: Include the following features:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
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.

K. Buses and Connections: 3-phase, 4-wire, unless otherwise indicated. Include the following features:

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98% conductivity with feeder circuit breaker line connections.
2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure 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" x 2" minimum size, drawn-temper copper of 98% 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. Contact Surfaces of Buses: Silver plated.
5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Tapered bus (vertical or horizontal) is unacceptable. Provide for future extensions from both ends of the switchboard.
6. Busway terminating at switchboard shall be bus connected. Cable connections are unacceptable.

7. Bus bars shall be arranged throughout A-B-C left to right, top to bottom, and front to rear. Bus bars shall be permanently labeled by phase. Bus joints shall be bolted with high tensile steel bolts with spring-loaded Belleville type washers.
9. Neutral Buses: 100% of the ampacity of the phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus is braced.

L. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit breaker compartment.

M. Bus-Bar Insulation: Factory-applied, flame-retardant, 105°C minimum tape wrapping of individual bus bars or flame-retardant, spray-applied insulation of same temperature rating.

N. Where the switchboard is used as Service Entrance Equipment, the equipment nameplate shall clearly state that the equipment is UL listed for use as Service Entrance Equipment.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Overcurrent Protection Device Types:

1. Main Device:

a. Molded case circuit breakers.

2. Branch Devices:

a. Molded case circuit breakers.

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 amps and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

C. Molded-Case Circuit breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

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 shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for 3-wire or 4-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1%
b. Phase-to-Phase Voltages, 3-Phase: Plus or minus 1%
c. Phase-to-Neutral Voltages, 3-Phase: Plus or minus 1%
d. Megawatts: Plus or minus 2%
e. Megavars: Plus or minus 2%
f. Power Factor: Plus or minus 2%
g. Frequency: Plus or minus 0.5%
h. Megawatt Demand: Plus or minus 2%; demand interval programmable from 5 to 60 minutes
i. Accumulated Energy, Megawatt Hours: Plus or minus 2%. Accumulated values unaffected by power outages up to 72 hours

2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.

2.6 CONTROL POWER

A. Control Circuits: 120-V, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. 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.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

C. Fungus Proofing: Permanent fungicidal treatment for switchboard interior, including instruments and instrument transformers.

2.8 IDENTIFICATION

A. Presentation Media: Painted graphics in color contrasting with equipment factory-finished background to represent bus and components, complete with lettered designations.

PART 3 - EXECUTION

3.1 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Support switchboards on concrete bases, 4-inch nominal thickness.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. 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.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.5 CONNECTIONS

A. Install equipment grounding connections for switchboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing Agency: Engage a qualified independent testing agency to perform specified testing.

C. Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. 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.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262413

This page intentionally left blank.

SECTION 262416
PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUBMITTALS

A. All exceptions to the specification shall be in written, detailed format with paragraphs referenced and presented with the shop drawing submittal. Refer to Division 01. Provide a written list with sections referenced of all the exceptions taken on this specification.

B. Product Data: For each type of panelboard, accessory item, and component specified.

C. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, available spaces, major features, and voltage rating. Include the following:

1. Enclosure type with details for types other than NEMA 250, Type 1
2. Bus configuration and current ratings
3. Short-circuit current rating of panelboard
4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components
5. Wiring Diagrams: Details of schematic diagram where applicable (i.e., shunt trip devices, breaker monitoring, metering, etc.), including control wiring and differentiating between manufacturer-installed and field-installed wiring
6. Quantity and wire range of lugs

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

G. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 01. Include manufacturer's written instructions for testing circuit breakers.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 01, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

C. Comply with NFPA 70.

D. Panelboards:

1. NEMA PB-1
2. Federal Specification W-P-115A Type II, Class 1
3. UL 50 and 67

E. Circuit Breakers:

1. NEMA AB-1
2. Federal Specification W-C-375a and W-C-375b
3. UL 489

1.4 MAINTENANCE

A. Extra Materials: Keys: Six spares of each type for panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Eaton Corp.
2. General Electric Co.; Electrical Distribution & Control Div.
3. Square D Co.; by Schneider Electric USA

2.2 FABRICATION

A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location. Enclosures shall be corrosion resistant galvanized (zinc finished) sheet steel. Fronts shall be cold rolled steel, finish coated with ANSI 49 and 61 gray enamel over a rust inhibitor. Panel locks shall be keyed alike. Recessed flush-mounted panels shall have overlapping front. All sections of multi-section panelboards shall be the same size.

B. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.

C. Directory Frame: Metal, mounted inside each panelboard door.

D. Bus System:

1. Bus bars shall be sequence phased, rigidly supported by high impact resistant, insulated supporting bus assemblies to prevent vibration and resulting damage when subjected to stress, vibration or short circuits. Solderless terminations shall be suitable for either copper or aluminum wire or cable.
2. Bus bars shall be tin-plated copper. Bus bars shall be of the ampere rating shown on the Drawings. Neutral bus shall be full size and of the same material as the phases buses. Neutral bus shall be 200% rated when supplied from a double neutral feeder. Provide copper equipment ground bus in each panelboard. In addition to the equipment ground bus, provide an isolated ground bus when supplied from a feeder which includes an isolated grounding conductor. Neutral and ground buses shall be capable of terminating one conductor per pole position minimum.

E. Main and Neutral Lugs: Mechanical type

F. Where a main breaker is indicated, it shall be factory mounted to the bus and shall be located in panel as indicated. Branch-mounted main breakers are prohibited.

G. Panelboards rated 240 VAC or less shall have short-circuit ratings as shown on the drawings, but not less than 10,000 amperes RMS symmetrical.

H. Panelboards shall be labeled with a UL short-circuit rating. Provide "FULLY" rated panelboard unless noted otherwise. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings of installed frames. It shall state the conditions of the UL series ratings, including:

1. Size and type of upstream device
2. Branch devices that can be used
3. UL series short-circuit rating

I. Molded-case as scheduled or required. Provide quick-make and quick-break toggle mechanism, inverse-time characteristics, and trip-free operation on overload or short-circuit.

Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide a trip element for each pole, a common-trip bar for all poles and a single molded insulating material handle. Handle ties will not be accepted. Adjustable magnetic trip devices shall be set at the factory to the low trip setting unless otherwise noted. Provide breaker frame sizes as required to meet the continuous ampere rating and the interrupting capacity. Provide G.F.I. type breakers/interrupters where indicated on drawings.

J. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.

K. Special Features: Include the following features for panelboards:

1. Door-in-Hinged Front Cover (Hinged Trim): Entire front trim hinged to box with standard hinged door with combined latch and lock within the hinged front. The cover shall have a continuous hinge on one side and machine screws into threaded holes in the panelboard cabinet on the other three sides. When open, the cover shall provide full access to the wiring gutters on three sides, and a minimum of 2-3/4-inch access on the hinge side without exposing live conductors.

L. Feed-through Lugs: Sized to accommodate feeders indicated.

2.3 PANELBOARDS

A. Overcurrent Protective Devices: Fixed mains, bolt-on full-module circuit breakers.

1. Circuit Breakers for Switching Lights at Panelboards: Indicated as Type SWD.
2. Circuit Breakers for Equipment Marked Type HACR: Indicated as Type HACR.

B. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.

1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
4. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
5. Shunt Trip: Where indicated.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: Arranged to permit testing of functions of solid-state trip devices without removal from panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. The directory shall clearly identify circuit numbers corresponding to the installed circuit breakers, and loads shall be identified by room number/area, type of load (i.e., printer, GFI receptacles, etc.), quantities, and other relevant information. Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Install plugs on open knockouts.

G. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Panelboard Nameplates: Nameplates for identifying the panelboards shall be engraved laminated plastic strips white with black letters black with white letters, attached by screws, or phenolic buttons or small window-frame type. Adhesive stick-on labels alone will not be acceptable unless specifically approved. Panelboard nameplates shall include name of panel, voltage, AIC rating, and where the panel is fed from.

3.3 GROUNDING

A. Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
2. Make continuity tests of each circuit.

B. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing.

C. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

D. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:

1. Perform measurements during period of normal working load as advised by Government.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Government to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. Recheck loads after circuit changes 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 required to meet this minimum requirement.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

B. Backboxes shall be clean, dry and free of construction debris and fireproofing overspray prior to installation of panelboard interior.

C. Vacuum backboxes clean of debris after installation and wiring of branch circuits.

END OF SECTION 262416

This page intentionally left blank.

SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading: Deliver all materials to the Work site in original, new, and unopened containers bearing the manufacturer's name and label.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Items of material furnished for the Work, subject to compliance with requirements, items listed or equal approved from manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wiring Devices:

a. GE Company
b. Hubbell, Inc
c. Leviton
d. Pass & Seymour/Legrand
e. Pyle National, Inc.; an Amphenol Co.
f. Molex

2. Multioutlet Assemblies:

a. Wiremold
b. Hubbell, Inc.

3. Dimming Switches:

    a. Leviton
    b. Lithonia
    c. Lutron Electronics Company, Inc.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Receptacles: Provide 125V, 20 A unless otherwise noted for installation in a 2-3/4-inch-deep outlet box without an adapter.

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 1 and WD 6, 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

F. Straight-Blade and Locking Receptacles: Heavy -Duty grade.

G. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

H. Devices for Government-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

I. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. SPD Devices: Blue.

J. Wall Plate Color: For plastic covers, match device color.

K. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.3 RECEPTACLES

A. Duplex Receptacles: All devices shall be duplex, configuration NEMA 5-20R, unless otherwise noted.

B. GFCI Duplex Receptacles: Feed-through type.

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Provide an indicator light that turns on when the GFCI has malfunctioned and no longer provides proper GFCI protection.
2. Standards: Comply with UL 943 Class A, and FS W-C-596.

C. Weather-Resistant GFCI Duplex Receptacle:

1. Description: Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.
3. Provide metal weatherproof-while-in-use covers.

D. USB Charging Receptacles:

1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles: Dual, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
3. Standards: Comply with UL 1310 and USB 3.0 devices.

E. Duplex SPD Receptacles:

1. Description: Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
4. Standards: Comply with UL 1449.

2.4 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 TOGGLE SWITCHES, 120 V, 20 A

A. Single-Pole Switches, 120 V, 20 A:

1. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120 V, 20 A:

1. Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120 V, 20 A:

1. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120 V, 20 A :

1. Standards: Comply with UL 20 and FS W-S-896.

2.6 DECORATOR-STYLE DEVICES, 20 A

A. Decorator Duplex Receptacles, 125 V, 20 A :

1. Description: Two pole, three wire, and self-grounding. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.

B. Decorator, Tamper- and Weather-Resistant, Duplex Receptacles, 125 V, 20 A :

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

C. Decorator Single-Pole Switches, 120 V, 20 A :

1. Comply with UL 20.

D. Decorator, Antimicrobial, Single-Pole Switches, 120 V, 20 A :

1. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2. Standards: Comply with UL 20 and FS W-S-896.

2.7 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
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 and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FLOOR SERVICE FITTINGS

A. Flush-Type Floor Service Fittings:

1. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
2. Compartments: Barrier separates power from voice and data communication cabling.
3. Service Plate and Cover: Rectangular, die-cast aluminum with satin finish.
4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
5. Data Communication Outlet: Blank cover with bushed cable opening.

2.9 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, with factory-wired multioutlet harness.

B. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: As noted on drawings.
3. Wiring: No. 12 AWG solid, Type THHN copper, circuited as shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits 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, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black -filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections :

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813
FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
5. Coordination charts and tables and related data.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
4. Coordination charts and tables and related data.

1.4 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 FIELD 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Mersen
4. Littelfuse, Inc.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses; class and current rating indicated; voltage rating consistent with circuit voltage.

1. Type RK-1: 250 -V, zero- to 600-A rating, 200 kAIC.
2. Type RK-5: 250 -V, zero- to 600-A rating, 200 kAIC.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.
5. Type T: 250-V, zero- to 1200-A rating, 200 kAIC.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel, 0.05-inch-thick 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. Minimum of 3 full width shelves.
3. Finish: Gray, baked enamel.
4. Identification: "SPARE FUSES" in white core black phenolic 1-1/2-inch- high letters on exterior of door.
5. Fuse Pullers: Provide two for each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Intermixing of fuse type and manufacturers within the same series-connected circuit is prohibited.

B. Cartridge Fuses:

1. Service Entrance: Class RK1, fast acting.
2. Feeders: Class RK1, fast acting.
3. Motor Branch Circuits: Class RK1, motor duty, time delay.
4. Other Branch Circuits: Class RK1, time delay.
5. Control Transformer Circuits: Class CC, time delay, control transformer duty.
6. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is not up-side-down and readable without removing fuse.

B. Install spare-fuse cabinet(s) in the main electrical room, next to the equipment requiring the fuses, or where directed by the Government.

C. Fuse Blocks: Install fuses in fuse blocks rated for the respective fuse class.

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information inside of door of each fused switch.

END OF SECTION 262813

SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 REFERENCES

A. The latest edition of the following standards and codes, standard publications of professional organization are the minimum requirements for this work.

1. American National Standards Institute (ANSI)
2. Institute of Electrical and Electronic Engineers (IEEE)
3. National Electrical Manufacturer's Association (NEMA)
4. National Fire Protection Association (NFPA)
5. NFPA 70, the National Electrical Code (NEC)
6. Underwriters Laboratories, Inc. (UL)

1.3 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division 01 Specifications.
2. All exceptions to this specification shall be given in written format referencing the section and paragraph and stating the proposed alternative to the requirement.
3. The information continued in the submittal shall be complete in every respect, as partial submittals shall be cause for rejection.

B. Product data for disconnect switches, circuit breakers, and accessories specified in this section as follows:

1. Descriptive data and ratings for voltage, continuous current, maximum horsepower, and short-circuit rating
2. Dimensional plans, elevations, sections, and details
3. NEMA enclosure type and size
4. Cable terminal size, number, and material
5. Unit wiring diagrams depicting local and remote devices
6. Accessories device descriptive bulletins and product data sheets (i.e., shunt trip coil, undervoltage release, ground fault, auxiliary contacts, key interlocks, etc.)

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency, and marked for intended use.

B. Comply with NFPA 70, the National Electrical Code.

C. All equipment and materials will be new and unused and shall conform with the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance at no additional cost to the Government.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Disconnect Switches and Circuit Breakers: Acceptable manufacturers are listed below. All disconnect and circuit breakers shall be of the same manufacturer.

a. Eaton Corp.; Cutler-Hammer Products
b. General Electric Co.; Electrical Distribution & Control Div.
c. Square D Co.; Schneider Electric USA

2.2 DISCONNECT SWITCHES

A. Enclosed fusible and non-fusible switches, 1200-amp and smaller, NEMA KS1, heavy duty type with lockable handle, 600-volts, horsepower rated for motors as required. Number of poles and ampacity as noted or required by Code. Short-circuit rating shall be sufficient to withstand the available fault current or let-through current before the fuse melts without damage or change in rating.

B. Fusible switches 30- through 600-amperes shall be furnished with rejection class "R" or "J" type fuse clips.

C. Switches shall incorporate a safety cover interlock to prevent opening the cover with the switch in the "ON" position or prevent placing the switch in the "ON" position with the cover open. Provide a “defeater” for authorized personnel.

D. Handles shall have provisions for padlocking and shall clearly indicate the ON and OFF positions. Front cover doors shall be padlockable in the closed position.

2.3 FUSES

A. Fuses shall be Class K-1 and K-5 of rejection type for 600 amperes and below. Fuse voltage class shall be either 250 volt and shall be applied according to circuit voltage.

B. Coordinate the low-voltage fuses required for the project to provide basic selective protection and properly coordinate with the other associated protective equipment.

2.4 ENCLOSURE

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices in general area of equipment and accessible to maintenance personnel according to manufacturer's written instructions. Secure devices firmly to supporting structure with approved fasteners in a level and plumb manner. Verify voltage and amperage size and enclosure type of devices for each installation. Where practical, devices shall be mounted such that the top of switch is a maximum of 6'-0" above finished floor or surface.

B. Connect devices to wiring system and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

C. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse. Install labels indicating fuse replacement information on inside door of each fused switch.

D. Identify each device according to requirements in other sections of these specifications.

3.2 OVERCURRENT PROTECTIVE DEVICES

A. Install fuses where required as a protective device in conformance with equipment manufacturer's specified requirements and in accordance with the requirements of this section.

3.3 EQUIPMENT CONNECTIONS

A. Provide all final power connections for mechanical equipment. All equipment items will be furnished and set by others. Confirm with suppliers all rough-in data, e.g., electrical characteristics, dimensions, locations, type of connection, etc., prior to installation.

3.4 FUSE CABINET

A. Surface-mounted steel fuse cabinet shall be wall-mounted in the main electrical room and have a hinged front door and a flush catch with lock (panelboard type). The cabinet shall contain three spare fuses of each size and type used in the project. On front of hinged door, provide an engraved nameplate with black letters and white phenolic material screwed in place reading, "Spare Fuses."

B. On inside of door, provide the following information typewritten and covered with clear plastic, "Use these spare current-limiting fuses to replace fuses of the same current-limiting type that have blow. Replace fuses with ones of similar rating and class -- DO NOT INCREASE FUSE RATING OR CHANGE CLASS."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
2. Test continuity of each line- and load-side circuit.

B. Testing Agency: Engage a qualified independent testing agency to perform specified testing.

C. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint and plaster splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262816

SECTION 262913
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 REFERENCES

A. The motor controllers shall be designed, manufactured, and tested in accordance with the latest applicable standards.

1. American National Standards Institute (ANSI)
2. Institute of Electrical and Electronic Engineers (IEEE)
3. National Electrical Manufacturer's Association (NEMA)
4. National Fire Protection Association (NFPA)
5. NFPA 70, the National Electrical Code (NEC)
6. Underwriters Laboratories, Inc. (UL)
7. State, city, and local authorities

1.3 SUBMITTALS

A. Product Data: Product data for disconnect switches, circuit breakers, motor controllers, and accessories specified in this section as follows:

1. Descriptive data and ratings for voltage, continuous current, maximum horsepower, short-circuit rating, NEMA starter size and type, and overload heater size and type.
2. Dimensional plans, elevations, sections, and details.
3. NEMA enclosure type and size.
4. Cable terminal size, number, and material.
5. Unit wiring diagrams depicting local and remote control devices. Differentiate between manufacturer-installed and field-installed wiring.
6. Accessories device descriptive bulletins and product data sheets (i.e. control power transformer, control switches, pilot lights, auxiliary contacts, key interlocks, etc.)

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed controllers of a single type from a single manufacturer.

B. The use of IEC-rated controllers shall not be provided unless the controller is engineered to coordinate precisely with the characteristics of a specific motor, load, and operating conditions. Type IEC controllers shall only be used with factory-packaged equipment where the controller is designed and engineered for the motor they control.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency, and marked for intended use.

D. Comply with NFPA 70, the National Electrical Code.

E. All equipment and materials will be new and unused and shall conform with the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance and at no additional cost to Government.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Manual, Magnetic, and Solid-state Enclosed Controllers:

a. Eaton Corp.
b. General Electric Co.; Electrical Distribution & Control Div.
c. Square D Co.; Schneider Electric USA

2.2 MANUAL ENCLOSED CONTROLLERS

A. Description: NEMA ICS 2, Class A, with "ON/OFF" toggle action and overload element for fraction horsepower single-phase application. Enclosure type shall be as required by location. When a motor includes an integral overload device, provide a motor-rated switch without an overload element.

2.3 MAGNETIC ENCLOSED CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, size 1 and larger, unless otherwise indicated.

B. Control Circuit: 120-volt; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity.

C. Combination Controller: Factory-assembled combination controller and disconnect means.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses.
2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with magnetic only trip field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

D. Fuses: Fuses shall be Class K-1 and K-5 of rejection type for 600 amperes and below and Class L for over 600 amperes. Fuse voltage class shall be either 250-volt or 600-volt and shall be applied according to circuit voltage. Coordinate the low-voltage fuses required for the project to provide basic selective protection and properly coordinate with the other associated protective equipment.

E. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

2.6 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with space requirements, installation tolerances, and other conditions affecting performance.

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

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select rating of controllers to suit motor horsepower controlled (NEMA Size 1 minimum).

3.3 INSTALLATION

A. Refer to Division 26 Section "Common Work Results for Electrical," for general installation requirements.

B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Common Work Results for Electrical."

C. Enclosed Fused Controller: Install fuses in each fusible switch in accordance with requirements of this section.

3.4 IDENTIFICATION

A. Identify enclosed controller components and control wiring according to Division 26 Section "Common Work Results for Electrical."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

D. Provide all final power connections for mechanical equipment. All equipment items will be furnished and set by others. Confirm with suppliers all rough-in data, e.g., electrical characteristics, dimensions, locations, type of connection, etc., prior to installation.

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.
2. 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.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting solid-state controllers.

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.

3.8 ADJUSTING

A. Set field-adjustable devices and circuit-breaker trip ranges in accordance with the manufacturer's data.

3.9 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that enclosed controllers are installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain enclosed controllers.

1. Train the Government's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 01.
4. Schedule training with the Government, through the Contracting Officer, with at least seven days' advance notice.

END OF SECTION 262913

SECTION 264313
SURGE PROTECTIVE DEVICES FOR
LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUBMITTALS

A. Product Data:

1. Complete product data detailing compliance, or exception in a paragraph by paragraph listing, to all provisions of this specification.
2. Copies of documentation stating that the Surge Protection Device is listed from an NRTL (UL, ETL, etc) and are tested and listed to UL 1449. Include UL device listing VPR, MCOV, I-n, and information posted at www.UL.com, under Certifications, using UL Category Code: VZCA.
3. Indicate the type of internal or external fusing that is incorporated in the SPD system and what impact the fusing has on the performance of the device with respect to surge capacity and clamping levels.
4. Copies of test reports from an NRTL, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on a per mode basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.
5. Installation, operation and maintenance manuals: Provide one copy of the installation, start-up, operation and maintenance manuals for each type unit supplied.

B. Shop Drawings: Provide electrical and mechanical drawings that include detail on unit dimensions, weights, wire size, field connections and mounting provisions. Installation instructions shall clearly state whether the system requires an external overcurrent device to maintain the system’s UL 1449 listing.

C. Manufacturer's qualifications.

D. Warranty and warranty statement.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Each complete suppression unit shall be supplied by a manufacturer whose Quality System has been certified as compliant with ISO 9001 or has a UL-Certified Test Laboratory.

2. Manufacturers shall provide proof that they have been regularly engaged in the design, manufacturing and testing of SPD equipment for not less than 10 years.

B. Regulatory Requirements:

1. Each complete suppression unit shall be UL 1449 (Fourth Edition) listed.
2. Units shall bear the Voltage Protection Rating (VPR) issued by UL for all protected modes.
3. The complete SPD assembly shall have a UL assigned short circuit current rating (SCCR) of 200 kA. The SPD shall be marked with a short circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that short circuit current rating. If the short circuit rating of the device is less than the available fault current, then surge suppression-type fuses with fuseholder/disconnect must be included with the submittal.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer shall provide a product warranty for a period of not less than 5 years parts and labor;. Provide a copy of warranty statement clearly establishing the terms and conditions to the Government.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The listing of specific manufacturers below does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

1. Advanced Protection Technologies, Inc. (APT); including other manufacturer’s products using APT as an OEM
2. Citel, Inc.
3. Current Technology, Thomas & Betts Power Solutions
4. GE Power Quality
5. Innovative Technologies (Eaton)
6. LEA International
7. Liebert Corporation
8. MCG Surge Protection
9. Raycap, Inc.
10. Schneider Electric USA, Inc

2.2 MANUFACTURED UNITS

A. Equipment design shall provide a multi-stage parallel protector with voltage ratings as specified below. The equipment surge current rating minimum surge current, clamping

voltage, and maximum continuous operating voltage, shall be based on an 8 x 20 microsecond waveform per ANSI/IEEE C62.41 Category C3. Declared Maximum Continuous Operating Voltage (MCOV) shall be at least 115% of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL 1449 Fourth Edition.

B. Minimum nominal discharge surge current (I-n): 20kA.

C. Unit shall have not more than 10% deterioration or degradation of the UL 1449 Fourth Edition Voltage Protective Rating (VPR) due to repeated surges.

D. Unless indicated otherwise, the suppression system shall incorporate a hybrid design consisting of any of the following: 1) silicon avalanche diodes, 2) MOV arrays, and 3) filtering capacitors. These components shall optimally share surge currents to ensure maximum performance and long-term reliability. The system shall not utilize gas tubes, spark gaps, or other components that might short leading to power interruption.

E. Each protection array shall be capable of withstanding the indicated quantity of sequential 10,000-amp ANSI/IEEE C62.41 Category C3 impulses without degradation or failure. Each system must have indicator lights to report the status of each surge suppression mode (L-N, L-G, N-G, etc.). Indication of AC line status only is not acceptable. The failure of a single MOV shall result in annunciation via an indicating light. Systems that require external testing equipment or tests to insure proper surge protection operation are expressly excluded. Unit shall have a monitoring option available to be able to test and determine the percentage of protection available at all times.

F. The complete SPD assembly shall have a UL assigned short circuit current rating (SCCR) of 200 kAIC All overcurrent protection circuits shall be monitored and provide indication of suppression operability or failure.

G. Protection Modes: Protection modes are identified in the tables below and as appropriate for the application. Refer to the one-line diagrams for voltage ratings, 3-wire and 4-wire systems, system ampacities, and SPD Surge Rating. The SPD shall provide bi-directional, positive, and negative impulse protection for:

1. Line to Line (L-L)
2. Line to Neutral (L-N)
3. Line to Ground (L-G)(WYE or Delta)
4. Neutral to Ground (N-G)

H. Enclosure: NEMA 3R.

I. Environmental Requirements:

1. Storage Temperature: (-67 to +185°F)
2. Operating Temperature: (-40 to +140°F)

3. Relative Humidity: 0% to 95% (non-condensing)
4. Audible Noise: less than 45dB at (5 feet)
5. Operating Altitude: 0 to 18,000 feet above sea level

J. Integral Disconnect Switch:

1. The device shall have a safety interlocked integral disconnect switch with an externally mounted manual operator.
2. The switch shall disconnect all ungrounded circuit conductors from the distribution system to enable testing and maintenance without interruption to the facility's distribution system.
3. The switch shall be rated for 600 V ac.
4. The SPD device shall be tested to UL 1449 4th Edition listed with the integral disconnect switch and the UL 1449 VPR ratings shall be provided.
5. The integral disconnect switch shall be capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.
6. The line side of the integral disconnect shall be blocked off so that when the SPD is opened there is no direct access to the voltage present on the line side of the disconnect.

K. Each unit shall provide the following features:

1. Phase Indicator lights
2. Form C dry alarm contacts, 240 volts, 5A
3. Field testable while installed.
4. Measuring capability to indicate the percent protection available in SPD.

2.3 SPD FOR CASCADE APPLICATIONS

A. The SPD shall incorporate MOV technology allowing for transient surge and temporary overvoltage protection.

B. Unless indicated otherwise on the drawings, suppressors shall have the following minimum surge current ratings per mode, and not less than the switchboard/panelboard AIC rating.

400 – 800-Amp Main Distribution Panel:	100,000 amps/mode
100 – 400-Amp Panelboard:	80,000 amps/mode

C. Surge Current Capacities shall be as follows:

Surge Current Capacities		
SPD Surge Rating	**Protection Mode**	**Single Pulse Surge Current Capacity Per Mode**
300	L-N, L-G, N-G	300 kA
	L-L, per	600 kA

Surge Current Capacities		
SPD Surge Rating	**Protection Mode**	**Single Pulse Surge Current Capacity Per Mode**
	phase	
200	L-N, L-G, N-G	200 kA
	L-L, per phase	400 kA
100	L-N, L-G, N-G	100 kA
	L-L, per phase	200 kA
80	L-N, L-G, N-G	80 kA
	L-L, per phase	160 kA

D. Maximum voltage ratings shall be as follows:

Maximum Voltage Ratings				
System Voltage	**Protection Mode**	**MCOV**	**Clamping Voltage, C3 Comb. Wave 20kV, 10kA**	**UL 1449 Fourth Edition Voltage Protective Rating (VPR) 6kV, 3kA**
120/240 and 120/208	L-L	300	1,600	1,200
	L-N	150	980	700
	L-G	150	980	700
	N-G	150	1,170	700

E. The SPD system shall include noise filtering as measured by the MIL Standard 220B Insertion Loss Test method within minimum 90% of the following.

10 kHz	**100 kHz**	**1 MHz**	**10 MHz**	**Max at 142 kHz**
18.1 dB	44 dB	22.8 dB	15.3 dB	54.6 dB

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions: Examine the areas and conditions under which the transient voltage surge suppressors are to be installed and correct conditions detrimental to the completion of work.

B. Verify the proper application of the SPD (i.e., voltage, phases, etc.) and coordinate with upstream and downstream transient suppression. Assure that all neutral conductors are bonded to the system ground at the service entrance or the separately derived service transformer prior to installation of the associated SPD.

3.2 INSTALLATION/APPLICATION

A. Install the SPDs as indicated in the manufacturer's installation instructions, in accordance with the applicable portions of NEC, and in accordance with recognized industry practices to ensure that the product complies with requirements. NEC, State, and local codes will prevail.

B. Suppressors shall be installed without unnecessary bends and as close as practical to the equipment, switchgear, switchboard, or panelboard being protected in such a way to minimize connecting lead length. Suppressor leads shall not extend beyond either the manufacturer's recommended length or 3 feet, whichever is less, without approval. Unless indicated otherwise, install the circuit breaker (OCP) feeding the SPD in the top position of the switchboard or panelboard; mount the SPD above the section housing the circuit breaker. Use stranded conductors to connect between the OCP and the SPD. Bundle and twist all conductors including neutral and ground between the supply terminals and SPD 2 twists per 12 inches.

C. Switchboard-mounted suppressors shall be connected to the service by means of a fused disconnect switch. All interconnection wiring to source protected gear shall be per the manufacturer's recommendations; minimum sizes shall be #6 AWG stranded 80 kA SPDs, and minimum #2 AWG for 300 kA, 200 kA and 100 kA SPDs. Terminals shall be provided for all necessary power and ground connections.

D. Coordinate with other electrical work as necessary to interface installation of the surge suppression systems with other work on the site. This includes verification of ground conductor termination capabilities, coordination of SPD supply breaker/fuse if used, and verification of SPD location and space requirements on the switchboard, panelboard, etc.

3.3 FIELD QUALITY CONTROL

A. Site Tests, Inspection: Perform field testing on each device in accordance with manufacturer's recommended procedures. Inspect each SPD installation and provide the

Government with a letter stating equipment and installation meets intent of Contract Documents, and manufacturer's warranties and guarantees are in effect.

B. Manufacturers' Field Services: The manufacturer’s representative shall be available for consultation to provide all necessary instructions for proper installation of the equipment.

3.4 TRAINING

A. Provide up to two hours training of the theory, operation, maintenance, and troubleshooting of the SPD system.

END OF SECTION 264313

This page intentionally left blank.

SECTION 265100
INTERIOR LED LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

B. Refer to Division 26, Vibration and Seismic Requirements for Electrical Systems.

1.2 SUMMARY

A. This Section includes interior luminaires , luminaires mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

B. If information provided in the Luminaire Schedule conflicts with information provided in the specifications, then the higher cost requirements shall apply.

1.3 SUBMITTALS

A. Submit each item in this Article according to the Conditions of the Contract and Division 01 Specifications. Any submitted luminaire that differs in any manner from that scheduled or specified must be marked “exception.” Clearly indicate exact differences and include all manufacturers data as indicated. Show associated cost credit to Government. Complete working luminaire samples shall be provided equipped with a 120-volt cord and plug for any proposed substitution upon request of the Contracting Officer.

B. Product Data describing luminaires and emergency lighting units. Arrange Product Data for luminaires in order of luminaire designation. Include data on features and accessories and the following:

1. Outline drawings indicating dimensions and principal features of luminaires
2. Battery and charger data for emergency lighting units
3. Certified results of independent laboratory tests for luminaires and lamps for photometric performance
4. Installation instructions

C. Shop Drawings: Show details of nonstandard or custom luminaires . Indicate dimensions, weights, method of field assembly, components, features, and accessories.

1. Wiring Diagrams: Detail wiring for luminaires and differentiate between manufacturer-installed and field-installed wiring.

D. Coordination Drawings: Reflected ceiling plans and sections drawn to scale and coordinating luminaire installation with ceiling grid, ceiling-mounted items, and other

components in the vicinity. Include work of all trades that is to be installed near lighting equipment. These items include:

1. Soffits
2. Air outlets and inlets
3. Occupancy sensors
4. Access panels
5. Ceiling mounted projectors
6. Other ceiling mounted devices

E. O&M Data: Maintenance data for all luminaires shall be included in maintenance manuals specified in Division 01. Provide a list of all LED sources, LED drivers and power supplies used on project with the associated luminaire types; use ANSI and manufacturers' codes.

1.4 QUALITY ASSURANCE

A. Luminaires, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency.

B. Comply with NFPA 70.

C. FM Compliance: luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Government of other rights Government may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Batteries: Manufacturer's standard, but not less than ten years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for last nine years.

C. Special Warranties for LED Luminaires: Written 5-year warranty, executed by manufacturer agreeing to replace luminaires that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for LED Source Assemblies: Written 5-year warranty from date of manufacture but not less than 4 years from the date of Substantial Completion, for defective or non-starting LED source assemblies.
2. Special Warranty Period for Power Supply Units (PSUs) and Drivers: Written 5-year warranty from date of manufacture, but not less than 4 years from the date of Substantial Completion.
3. Special Warranty Period for Premature Lumen Depreciation on LED Package, LED Array, or LED Module: Written 5-year warranty including, but not limited to, the LED die, encapsulate, and phosphor. If the expected useful life of the luminaire system as defined in paragraph "LED-dedicated Luminaire Expected Life," below, is not maintained then the manufacturer shall replace the light source(s) or luminaires as needed.

1.6 COORDINATION

A. Luminaires , Mounting Hardware, and Trim: Coordinate layout and installation of Luminaires with ceiling system and other construction.

B. Luminaires controlled by dimming devices or systems: Coordinate load and dimming devices prior to submittals. LED drivers shall be compatible with dimming devices and or dimming system modules.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated for each type designation in the Luminaire Schedule shown on the electrical drawings. Proposed alternate manufacturer may be submitted provided that all of the features of the originally specified product are met and (if applicable) the Division 01 proposed alternate process is followed.

2.2 LUMINAIRE AND LUMINAIRE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85%

2. Specular Surfaces: 83%
3. Diffusing Specular Surfaces: 75%
4. Laminated Silver Metallized Film: 90%

E. Lenses, Diffusers, Covers, and Globes: 100% virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
2. Lens Thickness: 0.125 inch minimum, unless greater thickness is indicated.

F. Reflector Cones: All downlight reflector cones must conform to the following unless otherwise indicated.

1. Cones shall provide 45-degree lamp image cut-off when viewed from below.
2. Cones shall have a minimum thickness of .032-inch and be manufactured of uniform gauge Alcoa 3002 alloy, free of spin marks, or other manufacturing defects.
3. Cone flange shall be formed as an integral part of the cone and shall have identical appearance as inner part of the cone. Cone flange shall be perpendicular orientation to cone and shall not allow any visible light leaks when properly installed.
4. Plastic cones or trim rings are not acceptable.

2.3 LED DRIVERS

A. General: Unless otherwise indicated, features include the following:

1. Minimum Efficiency: 85%.
2. Operating Voltage: Match system voltage.
3. Power Factor: 0.9 or above.
4. Minimum Starting Temperature: Minus 40°F.
5. Power supplies: UL Class I or II output
6. Total Harmonic Distortion (THD): Less than or equal to 20%.

2.4 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: As scheduled.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.
2. Arrows: Include as indicated on drawings.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum-rated lamp life.
2. Arrows: Include as indicated on drawings.
3. Self-Exercising with Automatic Diagnostics of all Electrical Functions: Complete diagnostic cycles which includes routine battery discharge cycling carried out monthly. Any malfunction of the unit's battery, charger, transfer circuit or lamps shall be indicated by separate LEDs mounted in the emergency unit.
4. Battery: Maintenance-free nickel cadmium with minimum 10-year nominal life and full warranty on the battery with discharge cycling shall be a minimum of five years.
5. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80% of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. Relay disconnects, lamps and battery, and automatically recharges and floats on trickle charger when normal voltage is restored.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements: Self-contained units. Comply with UL 924. Units include the following features:

1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80% of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.
4. Self-exercising with Automatic Diagnostics of all Electrical Functions: Complete diagnostic cycles which includes routine battery discharge cycling shall be carried out monthly. Any malfunction of the unit's battery, charger, transfer circuit or lamps shall be indicated by separate LEDs mounted in the emergency unit.
5. Integral Time-Delay Relay: Arranged to hold unit on for fixed interval after restoring power after an outage. Provides adequate time delay to permit high-intensity-discharge lamps to restrike and develop adequate output.

2.6 LIGHT SOURCES

A. LED Sources:

1. Color Temperature and Minimum Color-Rendering Index: As indicated in the Luminaire Schedule, within 3-step MacAdam ellipses and minimum 80 CRI, unless otherwise indicated. Follow ANSI C78.377-2008 standards for specifying chromaticity tolerances for white LEDs

2. Provide manufacturer certifications of estimated luminaire life complying with the following:

   a. Lumen depreciation testing per IES LM-80-08 on the light source(s) (module/array) for a minimum of 6000 hours. Per IES LM 80-08, identify the case temperature measurement point (T_s) that is accessible to allow the temporary attachment of a thermocouple for measurement of the LED temperature when installed in the luminaire. When requested, provide LED and LED driver performance testing at more than a single standardized temperature following IES LM-82-12.
   b. Extrapolate lumen depreciation of the LED module/array (lumen degradation at three temperatures) using the IES LM-80-08 test data with a standard exponential decay curve fit.
   c. Identification of the operating temperature of the LED, installed in a luminaire using the Ts point under operating conditions as described in IES LM-79-08. Interpolate a decay curve between the three extrapolated degradation curves derived from IES LM-80 and exponential decay curve fitting using in-luminaire LED module/array temperature.
   d. Provide the time in operating hours when the luminaire is expected to reach L70 lumen output degradation from interpolated curve following IES TM-21-11.

3. LED-dedicated Luminaire Expected Life: A minimum of 50,000 operating hours before reaching L70 lumen output degradation point with no failures per IES LM-80-08.

2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Common Work Results for Electrical," for channel and angle-iron supports and nonmetallic channel and angle supports. Luminaire type catalogue numbers do not necessarily denote required mounting hardware and/or accessories. Provide all appropriate mounting hardware for all mounting conditions.

B. Single-Stem Hangers: 1/2-inch steel tubing with 45-degree swivel ball fitting and ceiling canopy. Finish same as luminaire.

C. Chain Hangers: Provide wire hangers and chains. Coordinate hanger type/size with luminaire manufacturer.

D. Rod Hangers: 3/8-inch-minimum diameter, cadmium-plated, threaded steel rod.

E. Power Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. Aircraft Cable Support: Provide stainless-steel cable, anchorages, and intermediate supports recommended by luminaire manufacturer.

2.8 FINISHES

A. Luminaires : Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects
2. Metallic Finish: Corrosion resistant

PART 3 - EXECUTION

3.1 VERIFICATION

A. Prior to ordering luminaires and installing any electrical conduit, wiring, and junction boxes, confirm all above ceiling depths to insure that recessed luminaires can be installed. Coordinate any above ceiling conflicts with Contracting Officer.

3.2 INSTALLATION

A. All luminaires shall be installed as indicated on architectural and electrical drawings. If there is a conflict, the luminaire locations on the electrical plans shall govern.

B. Connect all exit signs and emergency battery luminaires ahead of local switching or control system switching.

C. Luminaires: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each luminaire.

D. Remote Mounting of LED Drivers/Power Supplies: Distance between the LED driver/power supply and luminaire shall not exceed that recommended by LED driver/power supply manufacturer. Verify, with manufacturers, maximum distance between LED driver/power supply and luminaire.

E. Support for luminaires in or on grid-type suspended ceilings as per International Building Code.

1. All luminaires shall be positively attached to the suspended ceiling system. The attachment device shall have a capacity of 100 percent of the lighting luminaire weight acting in any direction.
2. When intermediate systems are used, 12-gauge hangers shall be attached to the grid members within 3 inches of each corner of each luminaire. Tandem luminaires may utilize common wires.
3. When heavy-duty systems are used, supplemental hangers are not required if a 48-inch modular hanger pattern is followed. When cross runners are used without supplemental hangers to support luminaires , these cross runners shall provide the same carrying capacity as the main runner.

4. Luminaires weighing less than 56 pounds shall have, in addition to the requirements outlined above, two 12-gauge hangers connected from the luminaire housing to the structure above. These wires may be slack.
5. Luminaires weighing 56 pounds or more shall be supported directly from the structure above by approved hangers.
6. Pendant-hung luminaires shall be supported directly from the structure above with 9-gauge wire or approved alternate support without using the ceiling suspension system for direct support.
7. Luminaires of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

F. Recessed Downlights and Wallwashers: Ceiling opening for recessed downlights and wallwashers shall not allow any light leaks and/or gaps between luminaire trim and ceiling. Luminaire overlapping flange trim shall fit tight against adjacent ceiling surface. Square aperture downlight trims shall be installed with side of trim parallel to room walls or ceiling tiles (if applicable).

G. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Pendant-mounted luminaires : Suspend with single-stem hangers.
3. Continuous Rows: Suspend from cable installed according to luminaire manufacturer's written instructions.
4. Linear luminaires : Surface-mounted or suspended luminaires shall not have more than 1/4-inch variation in alignment for any 16-foot run. Suspended luminaires shall have cable supports (unless otherwise noted in luminaire schedule) with straight white power cord feeds. In spaces with parallel rows of suspended luminaires , all cord feeds shall be installed in the same orientation within the room. Cable tie white cords to supports.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Advance Notice: Give the Contracting Officer representative a minimum two weeks advance notice to schedule dates and times for field tests.

C. Tests:

1. Verify normal operation of each luminaire after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
3. Verify normal transfer to battery source and retransfer to normal.
4. Report results in writing.

D. Malfunctioning luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

E. Installed Lighting Usage During Construction: Contractor shall minimize permanent installed lighting usage as much as possible during construction. All installed interior lighting on the project site shall be turned off at the end of the workday. All lamps and LED sources in new buildings shall have less than 100 hours of burn time or use.

3.4 CLEANING AND ADJUSTING

A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

B. As directed by Contracting Officer, adjust aimable luminaires. Provide all necessary personnel, lifts, and ladders to make adjustments. Inform the Contracting Officer at least 2 weeks in advance of time when luminaires will be ready for aiming.

END OF SECTION 265100

This page intentionally left blank.

SECTION 265600
EXTERIOR LED LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

B. Refer to Division 26, Vibration and Seismic Requirements for Electrical Systems.

1.2 PERFORMANCE REQUIREMENTS FOR POLES

A. Dead Load: Weight of luminaire and its horizontal and vertical supports applied as stated in AASHTO LTS with current interims.

B. Wind Load: Pressure of wind on pole and luminaire(s),shall be rated for 90 miles per hour wind, and 1.3 gust factor.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specifications. Any submitted luminaire that differs in any manner from that scheduled or specified must be marked “exception”. Clearly indicate exact differences and include all manufacturers data as indicated. Show associated cost credit to Government. Complete working luminaire samples shall be provided equipped with a 120-volt cord and plug for any proposed substitution upon request of the Contracting Officer. Provide electronic copy of any independent laboratory tested IES photometric file used in verifying that substituted luminaire meets the specifications.

B. Product Data describing luminaire, and poles. Arrange Product Data for luminaires in order of luminaire designation. Include data on features and accessories and the following:

1. Outline drawings indicating dimensions and principal features of luminaires and poles.
2. Certified results of independent laboratory tests for luminaires and photometric performance
3. Installation instructions

C. O&M Data: Maintenance data for all luminaires shall be included in maintenance manuals specified in Division 01. Provide a list of all LED sources, LED drivers and power supplies used on project with the associated luminaire types; use ANSI and manufacturers' codes.

1.4 QUALITY ASSURANCE

A. Luminaires and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use, location, and installation conditions by a testing agency .

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING OF POLES

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory applied pole wrappings on fiberglass poles until just before pole installation. Handle poles with web fabric straps.

D. Retain factory applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Government of other rights Government may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by manufacturer and Installer agreeing to replace external parts of luminaires and poles exhibiting a failure of finish as specified below. This warranty is in addition to, and not a limitation of, other rights and remedies Government may have under requirements of the Contract Documents.

1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.
2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.
3. Warranty Period: Manufacturer's standard, but not less than three years from date of Substantial Completion.

C. Special Warranties for LED Luminaires: Written 5-year warranty, executed by manufacturer agreeing to replace luminaires that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for LED Source Assemblies: Written 5-year warranty from date of manufacture but not less than 4 years from the date of Substantial Completion, for defective or non-starting LED source assemblies.
2. Special Warranty Period for Power Supply Units (PSUs) and Drivers: Written 5-year warranty from date of manufacture, but not less than 4 years from the date of Substantial Completion.

3. Special Warranty Period for Premature Lumen Depreciation on LED Package, LED Array, or LED Module: Written 5-year warranty including, but not limited to, the LED die, encapsulate, and phosphor. If the expected useful life of the luminaire system as defined in these specifications is not maintained then replace the light source(s) or luminaires as needed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated for each type designation in the Luminaire Schedule shown on the electrical drawings. Proposed alternate manufacturer may be submitted provided that all of the features of the originally specified product are met and (if applicable) the Division 01 proposed alternate process is followed.

2.2 LUMINAIRES

A. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

B. Metal Parts: Free from burrs, sharp corners, and edges.

C. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

E. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.

F. Gasketing: Door frame and housing sealed by one piece extruded silicon gasket with vulcanized end closure.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

I. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

J. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

K. Photoelectric Relays - Contact Relays: Single-throw, arranged to fail in the on position and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.

2.3 LED DRIVERS

A. General: Unless otherwise indicated, features include the following:

1. Minimum Efficiency: 85%.
2. Operating Voltage: Match system voltage.
3. Power Factor: 0.9 or above.
4. Minimum Starting Temperature: Minus 40°F.
5. Power supplies: UL Class I or II output
6. Total Harmonic Distortion (THD): Less than or equal to 20%.

2.4 LIGHT SOURCES

A. LED Sources:

1. Color Temperature and Minimum Color-Rendering Index: As indicated in the Luminaire Schedule, within 3-step MacAdam ellipses and minimum 80 CRI, unless otherwise indicated. Follow ANSI C78.377-2008 standards for specifying chromaticity tolerances for white LEDs
2. Provide manufacturer certifications of estimated luminaire life complying with the following:

a. Lumen depreciation testing per IES LM-80-08 on the light source(s) (module/array) for a minimum of 6000 hours. Per IES LM 80-08, identify the case temperature measurement point (T_s) that is accessible to allow the temporary attachment of a thermocouple for measurement of the LED temperature when installed in the luminaire. When requested, provide LED and LED driver performance testing at more than a single standardized temperature following IES LM-82-12.
b. Extrapolate lumen depreciation of the LED module/array (lumen degradation at three temperatures) using the IES LM-80-08 test data with a standard exponential decay curve fit.
c. Identification of the operating temperature of the LED, installed in a luminaire using the Ts point under operating conditions as described in IES LM-79-08. Interpolate a decay curve between the three extrapolated degradation curves derived from IES LM-80 and exponential decay curve fitting using in-luminaire LED module/array temperature.

d. Provide the time in operating hours when the luminaire is expected to reach L70 lumen output degradation from interpolated curve following IES TM-21-11.

3. LED-dedicated Luminaire Expected Life: A minimum of 50,000 operating hours before reaching L70 lumen output degradation point with no failures per IES LM-80-08.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS with current interims for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

B. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Performance Requirements" Article, with a gust factor of 1.3.

1. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

C. Luminaire Attachment: Structural supports to comply with luminaire mounting requirements.

D. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

E. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Will not cause galvanic action at contact points.
2. Mountings: Correctly position luminaire to provide indicated light distribution.
3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
4. Anchor-Bolt Template: Plywood or steel.
5. Concrete Bases: Cast-in-place concrete. Concrete, reinforcement, and formwork are specified in Division 03.

F. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.

2.6 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in length with access handhole in pole wall.

1. Shape: Square, straight.

B. Steel Mast Arms: NPS 2 black steel pipe, continuously welded to pole attachment plate.

C. Metal Pole Brackets: Cantilever brackets without underbrace, with straight tubular end section to accommodate luminaire. Match pole finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets, and securely fastened to pole top.

E. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. 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 cable times a 5.0 safety factor.

G. Brackets for Luminaires: Detachable, with pole and adapter fittings. Adapter fitting welded to pole and bracket, then bolted together with galvanized steel bolts.

H. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

I. Factory-Painted Finish: 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, "Solvent Cleaning," 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, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Interior Surfaces: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
3. Exterior Surfaces: thermoset polyester powder coat with 2.5 mil nomimal thickness applied over a titanated zirconium conversion coating.

    a. Color: As indicated by manufacturer's designations.

2.7 ACCESSORIES

A. Cast base cover, of same material and color as pole.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pole Concrete Foundations: Construct according to Division 3, Section "Cast-in-Place Concrete."

1. Comply with details for reinforcement and for anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.
2. Finish for Parts Exposed to View: Trowel and rub smooth. Comply with Division 3, Section "Cast-in-Place Concrete" for exposed finish.

B. Luminaire Attachment: Fasten to indicated structural supports or as indicated in Luminaire Schedule. Set level, plumb, and square with adjacent supports or walls, and secure according to manufacturer's written instructions and approved submittal materials.

1. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

C. Remote Mounting of LED Drivers/Power Supplies: Distance between the LED driver/power supply and luminaire shall not exceed that recommended by ballast or LED driver/power supply manufacturer. Verify, with manufacturers, maximum distance between ballast or LED driver/power supply and luminaire.

3.2 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 Division 26 Section "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50% overlap.

3.3 CONNECTIONS

A. Ground Equipment: 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. Ground metal poles/support structures according to Division 26, Section "Grounding and Bonding for Electrical Systems."

1. Poles: Install 10-foot driven ground rod at each pole. Use exothermic weld connection between ground rod and ground conductor.
2. Nonmetallic Poles: Ground metallic components of lighting units and foundations. Connect luminaires to grounding system with No. 6 AWG conductor.

3. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units. Replace burned out lamps.

B. Advance Notice: Give the Government's representative a minimum of two weeks advance notice to schedule dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and check excessively noisy ballasts.

E. Malfunctioning Luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.5 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. As directed by Contracting Officer, adjust aimable luminaires. Provide all necessary personnel, lifts, and ladders to make adjustments. Inform Contracting Officer/Government at least two weeks in advance of time when luminaires will be ready for aiming.

END OF SECTION 265600

SECTION 270500
COMMON WORK RESULTS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes common work results for communication systems; including, sleeves, sleeve seals, grout, firestopping, identification and labeling.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. RCDD: Registered Communications Distribution Designer.

1.3 SUBMITTALS

A. As specified in Division 1 Section “Submittal Procedures.”

1. Product Data: For each product indicated.
2. Shop Drawings: Include dimensioned plan and elevation views of each individual component. Show equipment assemblies, method of field assembly, workspace requirements, and access for cable connections.
3. System labeling schedules, including electronic copy of labeling schedules.
4. Submit lead installers certifications.
5. Sample warranties.
6. Wiring diagrams. Show typical wiring schematics including the following:

a. Workstation outlets, jacks, and jack assemblies.
b. Patch cords and patch panels.

B. Closeout Submittals: As specified in Division 1 Section “Closeout Procedures.”

1. Field quality-control test reports: Provide a printout of each cable segment to the Contracting Officer on three thumb drives.
2. Operation and Maintenance Data: Furnish with As-built drawings, diagrams, catalog data, parts lists, approved submittal data, manufacturer’s installation, operating and maintenance manuals for equipment and fixtures. Include copies of extended warranties.
3. Wire and Cable Drawings: Furnish three hard copies and two electronic records of wire and cable drawing and floor plans, in AutoCAD Release 2018 or later version. Prepare as-built drawings to a scale of 1/8” equals one foot. Identify

all wire, cable, cable tray layouts, and WAO locations with ID numbers on drawings. Include layout of conduit, buried wires, and stub outs.

4. Prepare and post copies of identification and labeling plans in each Telecommunication Room.
5. Warranties.

1.4 QUALITY ASSURANCE

A. Horizontal Cat 6 cable and outlet jacks: Provide products from a single manufacture.

B. The Contractor shall maintain current status with the warranting manufacturer products installed, for the duration of the Cable Infrastructure Project. Staff each installation crew with a minimum of 50% trained personnel, in accordance with their manufacturer/warranty contract agreement.

C. Manufacturers: Engaged in the manufacture of telecommunication wiring products of types, sizes, and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

D. Lead Installer's Qualifications: Include equipment manufacturers (copper cable and fiber optic cable) certification for product installation and at least 5 years of successful installation experience with projects utilizing telecommunication-wiring work similar to that required for this project

E. Personnel must be certified to install all Cat 6 and Fiber Optic wiring, cable, terminations, and equipment. Certification from BICSI level TE-350 or equivalent manufactures certification for installation work is the acceptable standard.

F. General Performance, Backbone and horizontal cabling system: Comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

G. 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.

H. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

I. Grounding: Comply with ANSI-J-STD-607-A.

J. The telephone raceway system and associated systems shall meet the requirements of the local telephone company.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. Allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. Provide for ease of disconnecting the equipment with minimum interference to other installations.
3. Allow right of way for piping and conduit installed at required slope.
4. Install connecting pathways, cables, wire-ways, cable trays, and busways clear of obstructions and clear 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 communications items that are behind finished surfaces or otherwise concealed.

D. Coordinate sleeve selection and application of fire-stopping.

1.6 EXTENDED PRODUCT WARRANTY

A. At completion of the installation and testing and acceptance by a manufacturers certified installer, provide a manufacturer's extended product, labor and materials warranty of at least 1 year assurance of compliant performance based on latest revision of ANSI/TIA/EIA-568 for the backbone and horizontal copper and fiber optic cable system infrastructure.

B. After installation, submit all documentation to support the warranty in accordance with the manufacturer’s warranty requirements, including test results, and apply for warranty on behalf of the government. The system warranty shall cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and equipment furnished and installed shall meet the standards of EIA/TIA, IEEE, UL, NFPA, and NEC and shall bear their label wherever standards have been established and label service is available.

2.2 SLEEVES FOR PATHWAYS AND CABLES

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

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

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.3 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FIRESTOPPING

A. N/A

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Identification Device Colors: Use those prescribed by ANSI A13.1.

C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.

D. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

E. Fiber Optic and Cable Tags: Blank or pre-printed, moisture and grease resistant, self-laminating tags made of rigid PVC material with a polyester self sealing cover and slotted holes for attachment.

F. Cable ties: Nylon type for attachment of tags.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights 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 communications 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 COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, 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. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening. Install rectangular sleeves at cable tray penetrations of ceilings and wall assemblies.

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 (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway 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 pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

K. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway 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 pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and

sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. N/A

3.5 IDENTIFICATION, LABELING, AND DOCUMENTATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

B. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

C. Labeling System: Provide a wiring numbering system in which a single sequence of numbers does not serve more than one office number.

D. Termination Devices: Stencil and label in accordance with ANSI/TIA/EIA606-A standard.

E. Label each twisted-pair wire patch panel in the ER patch panels immediately next to its modular jack.

F. Label termination punch down blocks at the EF to correspond to the ER patch panel terminations. Label the terminal punch down blocks on the top of the mounting cover with the same number.

G. Workstation:

1. Identify each WCO location with a unique alpha-numeric designation that defines its physical location in the building. The unique designation should identify the floor, grid, zone, or room, work station, and jack location in cover plate. Label a matching termination point (modular jack) with the same alpha-numeric designation in a patch panel in the TR and ER.
2. Identify each WAO outlet jack and patch panel jack with a permanent machine-made label containing the unique WAO location designation.
3. Label cables within outlet boxes.

H. Wiring: Identify wires at both termination ends for 9 feet with a numeric or alpha-numeric designation.

I. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each outlet/jack, cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building- mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

J. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A.

K. On cables, use flexible vinyl or polyester that flexes as cables are bent.

L. Wire and Cable Drawings: Post in prominent location in each telecomm equipment room or wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Show building floor plans with wire and cable labeling and layout.

M. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

END OF SECTION 270500

SECTION 270526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes ground rods, grounding conductors, connectors, and busbars.

1.2 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

1.3 SUBMITTALS

A. As specified in Division 1 Section “Submittal Procedures.”

1. Product Data: For each product specified.

1.4 QUALITY ASSURANCE

A. Grounding: Comply with ANSI-J-STD-607-A.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

B. Ground Rods: One piece, copper or copper-clad steel rod, 3/4 inches by 120 inches.

2.2 GROUNDING CONDUCTORS

A. Comply with UL 486A-486B.

1. Insulated Conductors: UL-83 stranded copper wire with green-or green with yellow stripe colored insulation. Insulated for 600 V.

2. Bare Conductors: Stranded copper cable complying with ASTM B8 or solid copper cable complying with ASTM B3.
3. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

C. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Telecommunications Main Grounding Busbar (TMGB): Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, 12-inch (300-mm) long. NRTL listed for use as TMGB and comply with J-STD-607-A.

1. Predrill with holes for use with lugs.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Stainless steel brackets and bolts.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrill with holes for use with lugs.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584- mm) equipment racks. Include a copper splice bar for transition-

ing to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Bond between the ac utility power service entrance, the communications cable entrance, and the grounding electrode system.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.2 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.
4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. Install the grounding and bonding conductor pathway through a plenum in EMT.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.3 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.4 GROUNDING BUSBARS

A. Install busbars horizontally, on insulated spacers, 12 inches (300 mm) above finished floor unless otherwise indicated.

3.5 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to bus-bars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB using No. 2 AWG bonding conductors.

F. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond TGB or TGMB to the ground bar of the panelboard.

G. Cable and Basket Tray Grounding: Bond to TGB or TGMB. Bond tray sections together unless tray is listed as self bonding.

1. Cable Tray Equipment Grounding Wire: No. 8 AWG.
2. Cable Tray Grounding Jumper: Not smaller than No. 10 AWG and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with one-hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

H. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

I. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Comply with NFPA 70. The equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.6 FIELD QUALITY CONTROL

A. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 270526

This Page Left Intentionally Blank

SECTION 270528
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes conduits, cable pathways, fittings, supports, boxes, enclosures, cabinets, and hand holes for exterior and interior cabling.

1.2 DEFINITIONS

A. ENT: Electrical nonmetallic tubing.

B. Wire Management Hardware: Cable hooks, wire ties, and mounting bases, bridal rings, brackets, clips, and other similar devices to provide support or bundling for cables. Screw or other permanently mounted system.

1.3 SUBMITTALS

A. As specified in Division 1 Section “Submittal Procedures.”

1. Product Data: For each product specified.

1.4 QUALITY ASSURANCE

A. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

PART 2 - PRODUCTS

2.1 UNDERGROUND CONDUITS AND FITTINGS

A. Conduit: ASTM F2160, UL 651A or UL 1990, high density polyethylene (HDPE) pipe, Schedule 80, manufactured from a resin material complying with ASTM D 3350 with a cell classification of PE334480C or E and conforms to NEMA TC-7 for Smoothwall Coilable PE Electrical Plastic Conduit.

B. Fittings:

1. Butt Fusion Fittings: PE3608 HDPE.
2. Electrofusion Fittings.

C. Vertical bends: Long sweep Schedule 40 or Schedule 80 PVC with belled or coupled ends.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.
3. Match fittings to conduit or tubing type and material.

B. ENT: NEMA TC 13.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651B.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 SURFACE PATHWAYS

A. Non-metallic wiring raceway system, including; wiring duct with hinged or removable cover, outlet boxes, wiring retainers, fittings and accessories.

2.4 BUILDING RACEWAY SYSTEMS

A. Conduit: As specified in Division 26, “Conductors, Cables, and Raceways.”

2.5 D-RINGS AND J-HOOKS

A. Cable Support: NRTL labeled for support of cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Size rings and hooks to provide strength for twice the applied load minimum.

C. Provide a minimum of 1 inch, flat or almost flat surface for cable support where installed over 12 inches (300 mm) center to center.

D. Metal Rings and Hooks Finish: Galvanized steel, paint powder coated, or aluminum with clear anodized finish.

2.6 INNER DUCT CORRUGATED CONDUIT

A. General: Meeting UL 2024 flame requirements for riser or general purpose applications. ASTM D4216 HDPE, flexible, non-metallic, corrugated raceway with pre-installed pull tape for fiber-optic cables. NEC 770 rated for fiber optical cables. NEC 800 rated for communication cables

1. Color: Orange.
2. Markings: Sequential footage markings and product identification printed every 2 feet.
3. Plenum Rated Inner Duct: UL 910 listed for plenum applications.
4. Riser Rated Inner Duct: UL 2024 listed for riser applications.

2.7 EXTERIOR PULL BOXES

A. Exterior Roof Vault: Series AWI – Same as AW Series w/Pre-Insulated curb, 6" Thick, R-40 Factor, to meet ICC – 2015 Energy Code. (The AWI model allows the A/E to comply with new Building Envelope Requirements to ensure that the complete envelope is insulated to Energy Code Regulations for every area in the country with one insulated curb.)

1. Wall flange is Stainless Steel, Cover is Aluminum
2. 85 SRI finish – Beige (Optional 100% White available)
3. Stainless, V.P. Fasteners to attach Frame To Cover (Note Fastener from Frame to Wall by Contractor to be compatible to Wall Surface).
4. Gasket Between Wall & Frame to be Adhesive Butyl, & between Cover & Frame to be
   Sil-X-14
5. Sil-X-14 Gasket & Aluminum Exit Seals
   Series 5000 - .25-1.9" Penetrant O.D.
   Series 6000 – 2.0-3.5" Penetrant O.D.
   Series 7000- 3.5"+ Penetrant O.D. Double Flange on Larger Diameter
6. Seismic Compatibility available. Local engineer to provide data to RPH

2.8 BOXES, ENCLOSURES, AND CABINETS

A. Wall Mounted Work Station Interface Boxes: Provide with drywall/plaster ring for wall covering.

1. 2" x 3" pressed steel standard outlet box and able to accommodate two 3/4" conduits.
2. 4" x 4" pressed steel standard outlet box.

B. Faceplates: Standard NEMA size, high-impact plastic, available in single gang (2, 4, 6-port) and double gang (8, 12-port) sizes. Color to match receptacles.

1. Accommodate self-adhesive labels and icon holes.
2. Provide with "leveling" screw holes to allow the faceplate to be adjusted.
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

C. Floor-Mounted: Flush, floor-mounted boxes with a hinged lid for recessed data and power outlets.

1. Die-cast metal box with 400 pound point load capability and rated for floor system loading.
2. Door: Allows cords to connect within box when lid is closed.
3. Lid: Recessed top with insert of surrounding floor material installed.
4. Provide with two-CAT 6E data jacks, one 20 amp power outlet, and one 20 amp computer circuit outlet.
5. Coordinate with Division 26, “Wiring Devices.”

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors:

1. Aboveground Conduit, Including the first 6-inch (150-mm) when penetrating grade level: RNC, Type EPC-80-PVC.
2. Underground Conduit: HDPE; or RNC, Type EPC-40-PVC

B. Indoors:

1. General Exposed, Subject to Severe Physical Damage and Damp or Wet Locations: Treat as if pathway were outdoor.
2. Pathways for Horizontal Cabling General: Cable tray pathway as called for in Division 27 “Cable Trays for Communication Systems.”
3. Exposed, Outside Cable Tray Pathway, Not Subject to Severe Physical Damage: RNC identified for such use.
4. Concealed but accessible in Attic or Crawl Space: D-rings or J-hooks may be used instead of conduit.
5. Concealed in Interior Walls and Partitions: ENT or EMT.
6. Boxes and Enclosures: NEMA 250 Type 1.

C. Pathway Fittings: Compatible with pathways and suitable for use and location.

D. Install surface pathways only where indicated on Drawings.

E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION, GENERAL

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

3.3 UNDERGROUND COMMUNICATION INSTALLATION

A. Excavation, trenching, backfilling, warning tape, tracer wire, and pull boxes: Comply with Division 31 section, "Trenching, Bedding, and Backfill for Utilities." Install trenches as straight and direct a line as possible.

B. Install exterior raceways in a raintight system sloping to drain toward the building exterior. Slope conduit with a minimum of 6 inch fall per 100 feet of conduit towards the manhole.

C. Install no more than equivalent of two 90-degree bends between pull boxes or ends. Use pullboxes or handholes to make sharp changes in direction.

D. Utilize Schedule 40 or Schedule 80 PVC elbows for vertical bends. Do not "sweep" pipe up to grade.

E. Install bends utilizing manufactured factory long, sweeping bends with a ten times the internal diameter of conduits.

F. Cap conduits with manufactured caps when installation is temporarily stopped or halted. After conduit installation, install sealing plugs to seal innerducts and conduits used or unused.

G. Install bushing on all conduit terminations.

H. Clean conduits by passing a wire brush mandrel or rubber duct swab until all foreign materials and water are removed. Check conduits by pulling a round test mandrel, 1/4" less than conduit size for each duct from both directions to remove obstructions.

I. Connections into Pull Boxes: End coil-able duct 4 to 5 feet from pull box. Transition coil-able duct to the same size PVC before connecting into the structure.

3.4 BUILDING CABLE RACEWAY SYSTEMS

A. Provide and install adequate sized conduits and pathways for service provider's requirements into the facilities demark point/room.

B. Install telecommunication systems in an independent raceway system and separated from all other electrical raceway systems. Install raceways for wiring distribution systems between the following:

1. Telephone Company Feeder and Demarcation Point (DP).
2. Equipment Rooms to Telecommunication Rooms.
3. Wall mounted work area outlet boxes into crawl spaces or accessible ceiling and attics if concealed in the wall, and in cable trays if located above accessible ceiling or accessible under-floor systems.
4. Between Floors: Install 4-inch conduit stub extending 4-inch minimum above the finished floor.
5. Telecommunication Pathways Above the Ceiling:

    a. Provide cable support at maximum 8 inch intervals. Use extended hangers where cables pass below ductwork or other large obstructions.
    b. Install 12 inch clear vertical space above the tray/basket type systems and 6 inches clear below the cabling pathways to the suspended ceiling.

6. Provide raceways for cable support when bundles of 10 or more horizontal cables follow the same pathway.

C. Install conduit to meet NEC and requirements in the BICSI TDM manual.

D. Bond and ground conduits according to ANSI J-STD-607-A.

E. Protect interior cables from physical damage. In new construction, install conduit concealed. In existing construction, install conduits in concealed locations where practical.

F. Support raceways in accordance with manufacturer's recommendations using screw or other permanent fastening method.

G. Do not lay cable and conduits upon attic joists, suspended ceiling panels, duct work and other similar items.

H. Support riser conduits at each floor level with clamp hanger.

I. Utilize sweeping bends or pull boxes when changing direction. Locate above ground pull boxes a maximum of 100 feet apart.

J. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Coat surfaces of dissimilar metals with corrosion inhibiting compound before assembly.

K. Space raceways at least 12 inches from other electrical system raceways or shield to prevent EMT.

L. Keep conduits a minimum of 6 inches from parallel runs of flues, hot water pipes or other sources of heat.

1. Where possible, install horizontal raceways above water and away from steam piping.
2. Do not route conduits across pipe shafts or duct openings.

M. Mechanically fasten together metal conduits, enclosures, and raceways for conductors, to form continuous electrical conductor. Connect to electrical boxes, fittings, and cabinets to provide electrical continuity.

N. Secure conduit terminations in metal enclosures with 2 locknuts and terminate with plastic bushing. Install locknuts inside and outside enclosure.

O. Conceal pathways within finished walls, ceilings, and floors unless otherwise indicated. Install pathways parallel or perpendicular to building lines unless otherwise indicated.

P. Support conduit within 12 inches (300 mm) of enclosures to which attached.

Q. Stub-ups to Above Ceilings:

1. Install pathway sleeves to access point beyond any access obstruction to another pathway type.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
3. Secure conduits to backboard when entering room from overhead.
4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

S. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. D-Rings and J-Hook Pathways: For each pathway where allowed in supporting horizontal cabling leaving or entering a main cable tray pathway or other pathway:

1. Install the first support to support cabling within 12 inches (300 mm) of the last pathway support.
2. Twelve or fewer 4-pair cables or equivalent: Install supports so that cables span a maximum of 60 inches (1520 mm).
3. More than twelve 4-pair cables or equivalent: Install supports so that cables span a maximum of 30 inches (760 mm).

U. Install backbone cables from ER to TR rooms in conduit or wire way. Keep separate from horizontal cables.

1. Innerduct Tubing: Install fiber optic cable in innerduct tubing in backbone pathway sized to accommodate the BICSI TDM recommended fill capacity. Install innerduct tubing inside conduit or wireway.
2. Install a backbone conduit containing an innerduct tubing conduit with a fiber optic cable and pull string for future cable replacement in cable runs exceeding 95 feet between buildings.
3. For Inter-Building backbone cabling where wire cable is used, install an underground conduit with cable and pull string for future cable replacement or addition.

V. Raceways to Work Area Outlets (WAO):

1. Install WAO at the same height as the nearby electrical outlets, recessed in the wall. Locate the WAO within 12 inches of an electrical outlet.
2. Install 3/4" ENT or EMT from each telecommunication WAO box, through the wall, to accessible locations above the ceiling or below the floor. Conduit size is based on the installed horizontal cables plus 2 spare uninstalled cables.
3. Terminate the conduit horizontally, above or below all obstructions and readily accessible, directed toward the horizontal pathway.
4. Support and secure telecommunication wiring a minimum of every 18 inches or per cable manufacturer's instruction, whichever is more stringent. Attach cables securely to building structure by mechanical means.
5. Do not lay cable upon attic joists, suspended ceiling panels, duct work and other items.
6. Support wiring in crawl spaces or attics by use of cable trays or flexible wire basket trays, bridal rings, d rings or J hooks.

W. Raceways to Floor-mounted Combination WAO and Power: Install system to allow access to both telecommunication ducts and electrical duct through one service fixture.

X. Raceway Sizing:

1. Size raceways per the most stringent requirement of NEC, ANS, IEIA/TIA 568B and 569, or NEMA VE-2 or this specification.
2. Entrance raceways and raceways to multiple buildings are sized to accommodate initial Access Provider cable requirements plus 100% growth.
3. Determine tray/basket raceway capacity in accordance with the manufacturer's maximum recommended load capacity. Do not exceed 50% fill capacity and stack cables no higher than 6 inches.
4. Size backbone and inter-building raceways for future cables as follows:

    a. Conduit Runs 50 to 100 feet: Size conduit to utilize not more than 33% of the conduit capacity.
    b. Conduit Runs 100 to 500 feet: Size conduit to utilize not more than 25% of the conduit capacity.
    c. Conduit Runs Over 500 feet or with two or more 90 degree bends: Install a pull box.
    d. Conduits Runs 50 feet or Less: Size conduits to utilize not more than 40% of the conduit capacity as indicated in the following table.

Conduit			Number of CAT 6 Cables									
Internal Diameter		Trade Size	Wire O.D. mm (in)									
mm	(in)		3.3 (.13)	4.6 (.18)	5.6 (.22)	6.1 (.24)	7.4 (.29)	7.9 (.31)	9.4 (.37)	13.5 (.53)	15.8 (.62)	17.8 (.70)
15.8	0.62	½	1	1	0	0	0	0	0	0	0	0
20.9	0.82	¾	6	5	4	3	2	2	1	0	0	0
26.6	1.05	1	8	8	7	6	3	3	2	1	0	0
35.1	1.38	1-1/4	16	14	12	10	6	4	3	1	1	1
40.9	1.61	1-1/2	20	18	16	15	7	6	4	2	1	1
52.5	2.07	2	30	26	22	20	14	12	7	4	3	2
62.7	2.47	2-1/2	45	40	36	30	17	14	12	6	3	3
77.9	3.07	3	70	60	50	40	20	20	17	7	6	6
90.1	3.55	3-1/2	-	-	-	-	-	-	22	12	7	6
102.3	4.02	4	-	-	-	-	-	-	30	14	12	7

Y. Conduit for Radio Tower or Roof Mounted Radio Antennae: 2-inch rigid steel conduit.

3.5 BUILDING CABLE RACEWAY SYSTEMS

A. Provide and install adequate sized conduits and pathways for service provider's requirements into the facilities demark point/room.

END OF SECTION 270528

SECTION 270536
CABLE TRAYS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cable trays.

1.2 SUBMITTALS

A. As specified in Division 1 Section “Submittal Procedures.”

1. Product Data: For each product specified.
2. Shop Drawings: Include dimensioned plan showing general route of cable tray.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Source Limitations: Obtain cable trays and components from single manufacturer.

2.2 LADDER CABLE TRAYS

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

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. Chalfant Manufacturing Company.
3. Cooper B-Line, Inc.
4. Mono-Systems, Inc.
5. MP Husky.
6. Niedax-Kleinhuis USA, Inc.

B. General: Ladder cable tray including factory manufactured tees, crosses, risers, elbows, and other fittings of the same material as the main sections.

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 9 inches (225 mm) o.c.
3. Width: 12 inches (300 mm).
4. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.

5. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
6. No portion of the rungs shall protrude below the bottom plane of side rails.
7. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
8. Minimum Usable Load Depth: 2 inches (50 mm).
9. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
10. Fitting Minimum Radius: 12 inches (300 mm).
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.3 WIRE-BASKET CABLE TRAYS

1. N/A

2.4 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 BUILDING CABLE RACEWAY SYSTEMS

A. Coordinate cable tray installation with pathway installation in Division 27, “Pathways for Communications systems.”

3.2 CABLE TRAY INSTALLATION

A. Install ladder cable trays above equipment in communications rooms to provide cable and equipment support and are installed above the equipment.

B. Install wire basket trays for main pathways for containing communications cable. Low voltage electronic safety and security cables may also be installed in wire basket trays. Mount above accessible ceiling.

C. Install cable trays according to NEMA VE 2.

D. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

E. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

F. Remove burrs and sharp edges from cable trays.

G. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

H. Fasten cable tray supports to building structure.

I. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg).

J. Support bus assembly to prevent twisting from eccentric loading.

K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

L. Support wire-basket cable trays and similar products with center support hangers with 1/4-inch- (6-mm-) diameter rods.

1. Use 3/8-inch- (10-mm-) diameter rods where rods longer than 48 inches (1200 mm) are installed or where loaded basket weight requires them.
2. Do not exceed manufacturers spacing requirements.

M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

O. Make changes in direction and elevation using manufacturer's recommended fittings.

P. Make cable tray connections using manufacturer's recommended fittings.

Q. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.3 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 and as specified in Division 27 "Grounding and Bonding for Communications Systems."

B. Bond cable trays together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

3.4 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

3.5 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that communications or data-processing circuits are separated from power circuits by barriers.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

3.7 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

This Page Left Intentionally Blank

SECTION 271100
COMMUNICATION EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes backboards, communications equipment racks and cabinets, and mounting elements.

1.2 DEFINITIONS

A. LAN: Local area network.

1.3 SUBMITTALS

A. As specified in Division 1 Section “Submittal Procedures.”

1. Product Data: For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Shop Drawings: For communications equipment room fittings include plans, elevations, sections, details, and attachments to other work.

a. Detail equipment assemblies, and location and size of each field connection.
b. Equipment racks and cabinets: Include workspace requirements and access for cable connections.
c. Grounding: Indicate location of grounding bus bar and its mounting detail.

B. Closeout Submittals: As specified in Division 1 Section “Closeout Procedures.”

1. Operation and maintenance data: Furnish diagrams, catalog data, parts lists, manufacturer’s installation, operating and maintenance manuals for equipment and fixtures.

PART 2 - PRODUCTS

2.1 GOVERNMENT FURNISHED PROPERTY

A. The government will furnish and install the following equipment:

1. Site servers.
2. Routers.
3. Switches.
4. VTC.
5. UPS.
6. Patch Cords.

2.2 MANUFACTURERS

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. ADC.
2. Belden Inc.
3. Berk-Tek Company.
4. Cooper B-Line.
5. Emerson Network Power Connectivity Solutions.
6. General Cable Company.
7. Hubbell Premise Wiring.
8. Leviton Commercial Networks Division.
9. Middle Atlantic Products, Inc.
10. Ortronics, Inc.
11. Panduit Corp.
12. Siemon Co. (The).
13. Tyco Electronics Corporation; AMP NETCONNECT.

2.3 BACKBOARDS

A. Backboards: 3/4-inch by 48-inches by 96-inches, type ACX, fire-retardant-treated plywood.

2.4 110 BLOCK INPUT 110 BLOCK OUTPUT BUILDING ENTRANCE PROTECTORS

A. Enclosure: UL listed, mill-galvanized steel housing with lock hasp, built-in splice chamber, gold-plated contacts, and lift-out protector panels. Provide exterior rated enclosure where located outdoors.

1. Provide 110 type input and output punch down blocks.
2. Provide 25 pair protector blocks.

B. 5 Pin Protection Modules: JZ gas tube construction, no heat coil, with standard gold plated 5-pin bases.

1. Gas–Tube Modules: Two-electrode high amperage ceramic non-radioactive, gas-tube surge arresters and fail safe mechanism.

2.5 EQUIPMENT RACKS AND CABINETS

A. General: Comply with ANSI/EIA/TIA-310-D. Provide with double screw rail and horizontal and vertical wire management systems.

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

B. Four Post, Floor-Mounted Racks: Modular-type, steel or aluminum construction. Chatsworth rack with double screw rail or equal.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Finish: Baked-polyester powder coat.
3. Equipment Racks: 84-inch high by 30-inch deep, freestanding, four post, open rack.

C. Two Post, Floor-Mounted Patch Panel Racks: Modular-type, steel or aluminum construction. Chatsworth rack with double screw rail or equal.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
2. Sizes and additional cable management channels are required in the cabling specifications.
3. Baked-polyester powder coat finish.
4. Dimensions: 84-inch, freestanding, two post, open rack.

D. Cable Management for Equipment Frames:

1. Vertical cable managers: 84-inch high, 6” wide, combination double sided, with cable tray on front, cable rings on back or equal. Chatfield 35571-703 or equal.
2. Horizontal cable managers: Single sided, 8.2” deep. Chatsworth Horizontal 2U model 35441-702 or equal.
3. Provide cable managers panels, one above and below each patch panel.

2.6 SWING OUT WALL CABINET

A. N/A.

2.7 POWER DISTRIBUTION UNITS (PDU)

A. Rack mounted power strip complying with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Eight, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
6. Cord connected with 15-foot (4.5-m) line cord.
7. Rocker-type on-off switch, illuminated when in on position.
8. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.8 PATCH PANELS

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. Ortronics Tech Choice®.
2. Panduit-NetKey®.
3. Leviton eXtreme®.

B. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

C. UL listed, Category 6 RJ-45, patch panels wired to T568B and accepts RJ-45, 8-position modular plugs. Provide 24-port, loaded version with universal wiring labels for installation to T568B wiring.

D. Provide with connector bodies, including plugs and jacks.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals. Coordinate with cabling in Division 27 "Communication Copper and Fiber Optic Network Cabling." Provide one jack for each four-pair UTP cable.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article and Division 27 “Pathways for Communications Systems.

3.2 SURGE PROTECTION

A. Install Building Entrance Protector on copper voice line at the entrance facility.

3.3 GENERAL INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Equipment mounted on walls: Provide sufficient space between equipment mountings to allow for access and future expansion.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment with Government's telecommunications and LAN equipment representative.

1. Meet jointly with local telecommunications provider and Government telecommunications representative to exchange information and agree on details of equipment arrangements and installation interfaces. Coordinate meeting with Contracting Officer 2 week in advance.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

F. Wiring Support and Organization:

1. Logically arrange wiring systems, patch panels, equipment racks; and cross-connected blocks. Allow for natural wiring progression, and growth with minimal wire crossing, and easy access to each component for testing and facilitating moves, additions, and changes.
2. Secure and support telecommunications wiring a minimum of every 30 inches and not more than 6 inches from equipment racks, frames, and terminals.

3. Install support devices above and below all termination devices to support the cross-connects.

G. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

H. Equipment frame mounting: Mount according to manufacturer's requirements securely to the building structure.

1. Coordinate blocking and framing as needed.
2. Bolt racks to floor with minimum 3/8" bolts and washers or other floor anchoring devices.
3. Bolt or clamp each rack to the overhead ladder or cable tray system to provide additional structural support to equipment racks.

3.4 BACKBOARD INSTALLATION

A. Install 4 ft x 8 ft backboards unless otherwise indicated. Mount with C side facing the wall.

1. Paint surface of backboard with a minimum of two coats of fire-resistant paint prior to installation of any equipment on the backboard.
2. Do not paint over manufacturer's label on the fire-resistant plywood.
3. Mount backboard 18-inches above finished floor elevation or with the top at the ceiling whichever comes first.

3.5 EQUIPMENT RACK INSTALLATION

A. Provide and install one 4-post patch panel rack.
1. For each rack provide the following:
   a. Wire management rack between each patch panel.
   b. One vertical wire management rack beside each rack.
   c. One power distribution units (PDU) within each rack.
   d. Grounding for each rack and equipment.

B. Install overhead ladder trays for support of workstation cabling and EF cabling to racks. Run ladder trays from the racks to all walls to provide support for cables.

C. Install patch panels and terminate cabling in the patch panels.

1. Provide and install 8 (or more as needed) patch panels. Terminate all homerun cables from Work Area Outlets and cables from any TR.
2. Provide and install 1 additional patch panels as spare panels. No cable terminations are required in spare panels.

D. Mount two inch high wire management device between patch panels and at the bottom of the last patch panel.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling as specified in Division 27, “Common Work Results for Communications."

B. Label each twisted-pair wire patch panel in the ER patch panels immediately next to its modular jack.

C. Label termination punch down blocks at the EF to correspond to the ER patch panel terminations. Label the terminal punch down blocks on the top of the mounting cover with the same number.

END OF SECTION 271100

This Page Left Intentionally Blank

SECTION 271200
COMMUNICATIONS COPPER AND FIBER OPTIC NETWORK CABLING

PART 1 - GENERAL

1.1 SUMMARY

A This Section includes:

1 UTP cable.
2 Fiber optics cable.
3 Cable connecting hardware and cross-connects.
4 Multiuser telecommunications outlet assemblies.
5 Telecommunications outlet/connectors.

1.2 SYSTEM DESCRIPTIONS

A Backbone Cabling Description:

1 Backbone cabling system provides interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
2 Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Do not use bridged taps and splitters as part of backbone cabling.

B Horizontal Cabling Description:

1 Horizontal cable and connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and connecting hardware are called a "permanent link," a term that is used in the testing protocols.

a Two telecommunications outlet/connectors shall be installed for each work area outlet unless otherwise specified on the drawings.
b Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
c Do not install bridged taps and splices in the horizontal cabling.

2 A work area outlet (WAO) includes components that extend from the telecommunications outlet/connectors to the station equipment.
3 The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

1.3 DEFINITIONS

1 BICSI: Building Industry Consulting Service International.

2 Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

3 Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

4 EMI: Electromagnetic interference.

5 IDC: Insulation displacement connector.

6 LAN: Local area network.

7 MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

8 Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

9 RCDD: Registered Communications Distribution Designer.

10 UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A As specified in Division 1 Section “Submittal Procedures,” Closeout Procedures,” and Division 27 Section “Common Work Results for Communication Systems.”

1.5 QUALITY ASSURANCE

A General Performance: Backbone and horizontal cabling system: Comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

B All materials and equipment furnished and installed shall meet the standards of EIA/TIA, IEEE, UL, NFPA, and NEC and shall bear their label wherever standards have been established and label service is available.

1.6 COORDINATION

A Coordinate layout and installation of communications pathways and cabling with Government's communications and LAN equipment representative and service providers.

B Adjust arrangements and locations of cross-connect and patch panels in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A Provide cable from one manufacturer for the entire project.

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 Berk-Tek; a Nexans company.
b General Cable Technologies Corporation.
c Legrand Ortronics.
d Leviton Commercial Networks Division.
e Tyco Electronics/AMP NETCONNECT; Tyco International Ltd.

2.2 OUTSIDE PLANT CABLING (INTER-BUILDING)

A Outside Cables (Inter-building): RDUP PE-89, outside plant (OSP) telephone cable, 22 AWG, shielded, twisted pair, solid copper wire, moisture resistant filled, listed for direct burial or installation in conduit. Provide 6 pair as indicated on drawings.

2.3 CATEGORY 6 CABLE

A General:

1 Performance Rating: Category 6 exceeding TIA/EIA-568-B.2-1 Category 6 and ISO/IEC 11801 Class E performance requirements on all parameters.

2 Comply with all of the performance requirements for current applications such as Gigabit Ethernet (1000BASE-Tx), 10/100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog and digital video and analog and digital voice (VoIP).

3 Cable performance shall be independently verified and characterized to 600 MHz. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70.

4 Comply with ICEA S-90-661 for mechanical properties.

5 Jack and Cable Color: Blue.

6 Unshielded Twisted Pair (UTP) Cable:
a Jacketing: Thermoplastic, lead free.
b Plenum CMP (NFPA 262, UL 910) and riser CMR (ANSI/UL 1666, IEC 332-1) rated where required based on installation location.

7 Horizontal Cable: 100-ohm, four-pair UTP, 23 AWG, unshielded. Manufactured by AMP NETCONNECT part number 219560-X, or 219567-X where X denotes color or equal.

2.4 UTP CABLE HARDWARE

A General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

1 Hardware and terminations for underground cables is in article “Input-Output Building Entrance Enclosure.”

B Jacks and Jack Assemblies: UL listed, modular, SL (slim profile) Series, color-coded, eight-position receptacle units with integral IDC-type terminals. AMP NETCONNECT part number 1375055-X, 1375187-X, 1375188-1 or 1479552-1 where X denotes color or equal.

1 Un-keyed, unshielded, 4-pair, RJ-45.

2 Terminate using 110-style pc board connectors, color-coded for T568B wiring.

3 110-style insulation displacement connectors:

a Capable of terminating 22-24 AWG solid or 24 AWG stranded conductors.

b Paired, with additional space between pairs to improve crosstalk performance.

4 Modular jacks shall utilize a secondary PC board, separate from the signal path, for crosstalk compensation.

5 Terminate jacks with a non-impact compression tool that terminates and cuts all 8 conductor with one action.

6 Provide each modular jack with a bend-limiting strain relief that provide cylindrical support to limit the bend radius at the point of termination. Each jack shall incorporate an integral, hinged dust cover.

7 Modular Jack Housing and 110 Connecting Blocks: Polyphenylene oxide, 94V-0 rated

a Contacts: Beryllium copper, plated with 1.27µm (50µin) thick gold in localized area and 3.81µm (150µin) minimum thick matte tin in solder area over 1.27 µm (50µin) minimum thick nickel under plate

b Insulation Displacement Contacts: Phosphorous bronze, plated with 3.81µm (150µin) minimum thick matte tin-lead over 1.27µm (50µin) minimum thick nickel under plate.

c Integral Dust Cover: Polycarbonate

d Shield: Copper zinc alloy 260, pre-plated with bright nickel with polycarbonate strain relief.

2.5 FIBER OPTIC ENCLOSURES

A N/A

2.6 FIBER OPTIC CABLE CONNECTORS, ASSEMBLIES, INSERTS, AND COUPLERS

A N/A

2.7 FIBER OPTIC CABLES

A N/A

2.8 IDENTIFICATION PRODUCTS

A Comply with Division 27 Section "Common Work Results for Communication Systems."

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A 110-Style Jacks: Terminate using EIA/TIA/ANSI 568B color designation wire connections. 568-B COLOR CODE

B Horizontal Cabling: Install 2 Cat 6, data cables to each data jack location unless additional jacks are indicated on the drawings or as listed below.

1 Wireless Access points: 1 data cable per location

2 Copy business center rooms: 3 data cables per locations identified per floor plan drawing.

C Backbone Cabling:

1 Terminate inter-building wire cables in BEP enclosures.

2 Use appropriately sized enclosures/panels for intra-building wire cables.

3.2 INSTALLATION OF CABLES

A Comply with NECA-1.

B General Requirements for Cabling:

1 Comply with TIA/EIA-568-B.1.

2 Comply with BICSI ITSIM, Chapter. 6, "Cable Termination Practices."

3 Install 66-style IDC termination hardware unless otherwise indicated.

4 Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

5 Do not splice cables.

6 Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals. Longer support distances may be allowed in other areas of this contract.

7 Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

8 Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

9 Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

10 Cold-Weather Installation: Bring cable to room temperature before de-reeling. Do not use heat lamps for heating.

11 In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.

12 Pulling Cable: Comply with BICSI ITSIM, Chapter. 4, "Pulling Cable." Monitor cable pull tensions.

13 Coordinate installation of workstation outlets with installation of systems furniture (by others).

C UTP Cable Installation:

1 Comply with TIA/EIA-568-B.2.

2 Do not untwist UTP cables more than 5/16 inch (8 mm) from the point of termination to maintain cable geometry.

D Open-Cable Installation In Telecommunications Spaces:

1 Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2 Do not run cable through structural members or in contact with pipes, ducts, or other potentially damaging items.

3 Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

4 Run cable into System Furniture Workstation Outlets and terminate in a Two-port-connector assemblies mounted in single faceplate. Leave ample service loop in areas that will supply multiple cubicles. Coordinate with furniture installation for final termination into cubical system furniture workstation outlets.

E Group connecting hardware for cables into separate logical fields.

F Separation from EMI Sources:

1 Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2 Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
b Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
c Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
b Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4 Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a Electrical Equipment Rating Less Than 2 kVA: No requirement.
b Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
c Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5 Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6 Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

7 Cross all power wiring at 90 degrees where possible.

3.3 FIBER OPTIC CABLE INSTALLATION

1 N/A.

3.4 FIELD QUALITY CONTROL

A Test the systems in the presence of the Contracting Officer.

B Test each cable segment with copper and fiber optic certifying devices (tester). Provide a printout of each cable segment to the Contracting Officer on three thumb drives.

C Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1 and 568B2-1.

D Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

E Cat 6 Cable Field Testing:

1 Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

2 Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

3 UTP Performance Tests: Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2 for Category 6 compliance:

a Wire map.
b Length (physical vs. electrical, and length requirements).
c Insertion loss.
d Near-end crosstalk (NEXT) loss.
e Power sum near-end crosstalk (PSNEXT) loss.
f Equal-level far-end crosstalk (ELFEXT).
g Power sum equal-level far-end crosstalk (PSELFEXT).
h Return loss.
i Propagation delay.
j Delay skew.

4 Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

5 End-to-end cabling will be considered defective if it does not pass tests and inspections.

F Fiber Optic Cable Testing: Test in accordance with ANSI/TIA/EIA-455-B and TIA/EIA TSB 72.

1 Connector Validation Test: for each optical connector assembly, use optical time domain reflectometer (OTDR) to determine loss does not exceed the connector's manufacturer's published mean loss and standard deviation value. Replace and retest connector assemblies not meeting manufacturer's published values.

2 Optical Path Loss Measurement: For each optical path, measure end-to-end attenuation after both ends of an optical fiber have been connectorized, dressed and mounted in outlets or panels. Include measured and calculated values in final report.

G Repair, replace, re-terminate and retest cables which do not meet the specified test requirements.

H Prepare test and inspection reports prior to acceptance for review and to be included in as builds documentation.

END OF SECTION 271200

SECTION 311000
SITE CLEARING

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. Protecting existing trees, shrubs, groundcovers, plants, grass, and other vegetation to remain or as designated by the Contracting Officer in pre-construction conference.

2. Removing existing trees, shrubs, groundcovers, plants, grass, and other vegetation.

3. Clearing and grubbing.

4. Stripping and stockpiling topsoil.

5. Removing above- and below-grade site improvements.

6. Disconnecting, capping or sealing, abandoning site utilities in place, and removing site utilities.

7. Removing existing fill.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.

2. Division 01 Section “Temporary Erosion and Sedimentation Control” for storm water erosion and sediment mitigation.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other

objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to be stockpiled or to remain on the Government's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions. Information required may also be included in Division 1 Section "Project Record Documents."

C. Traffic Control Plan prepared by qualified personnel to be submitted, reviewed and approved by the authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. Preconstruction Conference: Conduct conference at Project site as directed by the Contracting Officer prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Contracting Officer and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction. Submit traffic control plan to the authorities having jurisdiction prior to closing traffic ways. Traffic control plan shall indicate vehicular and pedestrian detours around the construction area and shall be in accordance with the Manual of Uniform Traffic Control Devices.

B. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Government's property will be obtained by the Contracting Officer before award of Contract. Authority and permits for performing indicated removal and alteration work on adjacent rights-of-way shall be obtained by Contractor.

1. Do not proceed with work on adjoining property until directed in writing by the Contracting Officer.

C. Protect improvements on adjacent and on Government's property.

D. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Government's premises in a location approved by the Contracting Officer. Items intended to be salvaged or removed and replaced are identified in the construction drawings.

1. Items indicated to be removed and salvaged within the public right-of-way that may not belong to the Government shall be turned over to the authority having jurisdiction.

E. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

F. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place and inspected.

G. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving," (PART 2 – PRODUCTS).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks, survey control points, monuments, property line pins and other reference points from disturbance during construction. If disturbed or destroyed, restore or replace at no cost to Government.

B. Provide erosion control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust from leaving project site.

C. Locate and clearly flag trees and vegetation to remain.

D. Protect existing site improvements to remain from damage during construction.

1. Restore or replace damaged improvements to their original condition, as acceptable to the Contracting Officer.

3.2 TREE PROTECTION

A. Erect and maintain temporary fencing around drip line of individual trees or around perimeter drip line of groups of trees to remain before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.

2. Do not permit vehicles, equipment, or foot traffic within fenced area.

3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.

2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.

4. Cover exposed roots with wet burlap to prevent roots from drying and backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Contracting Officer.

1. Employ a qualified arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.

2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist, and as approved by the Contracting Officer.

3.3 UTILITIES

A. Contractor will locate, identify, arrange for disconnect and seal or cap off utilities indicated to be removed before site clearing.

1. Verify that utilities indicated as abandoned have been disconnected and capped before proceeding with site clearing.

a. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand earth pressures that may result after ends of abandoned piping have been closed. Backfill pipes larger than 8-inches in diameter with flowable fill or another approved Controlled Low Strength Material (CLSM).

2. Arrange with utility companies having jurisdiction to shut off indicated utilities or to relocate utilities under their jurisdiction.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Government or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify the Contracting Officer not less than seven (7) days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without the Contracting Officer's written permission.

C. Excavate for and remove or abandon underground utilities as indicated on the plans.

1. Water Service: Shall be abandoned at the main. Abandonment will consist of removing the service from the corporation valve and closing the corporation valve and/or tapping valve. Water service pipe on the site that will no longer be used shall be removed in entirety. Water service at the existing warehouse connection point shall be preserved for the new water service to tie into. Refer to Division 22 specifications for water appurtenances to be installed within the warehouse.

2. Sanitary Service: Shall be removed starting at the manhole on the adjacent property. Remove existing pipe in its entirety and clean existing penetration of manhole to receive new pipe and water stop gasket. Sanitary service pipe on the site can be abandoned if not in conflict with new improvements or underneath proposed building footprint at the discretion and approval of the Contracting Officer. Piping in conflict with new improvements or beneath the proposed building shall be removed in its entirety.

D. Removal of underground utilities may also be included in Division 2 Sections covering site utilities. Removal of underground utilities may also be included in Division 15 Mechanical or Division 16 Electrical Sections.

E. After removal of underground utilities, as indicated, properly cap and/or plug existing lines to remain in accordance with authorities having jurisdiction.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

1. Do not remove trees, shrubs, and other vegetation indicated to remain.

2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

3. Grind stumps and completely remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.

4. Use only hand methods for grubbing within drip line of remaining trees.

5. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earth moving is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered or as determined by The Contracting Officer in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of stockpiles to 72 inches unless authorized by the Contracting Officer.

2. Do not stockpile topsoil within drip line of remaining trees.

3. Dispose of excess material as specified for waste material disposal.

3.6 SITE IMPROVEMENTS

A. Remove existing above and below grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, foundations, paving, curbs, gutters, and aggregate base as indicated on plans.

1. Remove existing foundations in their entirety. If foundations cannot be removed in their entirety, remove to a minimum depth of 3 feet below new foundations and a minimum of 2 feet below new pavements or flatwork.

2. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

4. Removal of existing asphalt or concrete pavements may include processing and reuse of materials as compacted fill provided they are mixed with satisfactory soils as approved by the Contracting Officer. Refer to Division 31 section “Earth Moving” for additional requirements.

C. Remove existing fill. Refer to Division 31 section “Earth Moving” for information regarding suitability for re-use and to Geotechnical Investigation for estimates of location/extent of existing fill.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the Government's property.

1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000

This page intentionally left blank.

SECTION 312000
EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Additional information concerning earth moving may be found on the civil drawings, in the project geotechnical report and Town of Carbondale construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning earth moving may be found in the geotechnical investigation report by Terracon Consultants, Inc. dated June 29, 2018 and clarification letter by Terracon Consultants, Inc. dated May 28, 2020. The recommendations provided in this report are for information and it shall be the Contractor's responsibility to field verify conditions indicated and follow the recommendations provided.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing and grading subgrades for slabs-on-grade, walks, pavements, and exterior plants.

2. Excavating and backfilling for buildings and structures including overexcavation of existing unsatisfactory on-site soil materials and replacement with structural fill.

3. Drainage course for slabs-on-grade.

4. Base course for asphalt or concrete paving.

5. Subsurface drainage fill for drainage infiltration area.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

2. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.

3. Division 01 Section “Temporary Erosion and Sedimentation Control” for erosion and sedimentation control measures.

C. Permits and Fees: Obtain and pay for all permits and fees required for the work of this section, including erosion and sediment control and water quality permits required by the Colorado Department of Public Health and Environment, Water Quality Control Division. Contractor to coordinate with the Government after award on obtaining the permit.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Bedding materials 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: Course placed between the subgrade and hot-mix asphalt or concrete paving.

C. Bedding Course: Course 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 approved by the Contractor’s Geotechnical Engineer.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Drainage Fill: 1” washed angular rock to be used within the drainage infiltration area. Percent passing No. 200 sieve shall be less than 5%.

G. Excavation: Removal of all material of various characteristics required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders. See Section 3.4 for definition of unclassified and classified excavation.

H. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed or approved by the Contracting Officer and the testing and inspections agency to correct unsatisfactory conditions.

I. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Contracting Officer. Unauthorized excavation including disposition of overexcavated materials and other work resulting

from slides, cave-ins, swelling, upheaval, or remedial work, as well as remedial work directed by the Contracting Officer, shall be without additional compensation.

J. Fill: Fill is all material placed to raise the grade of the site or to backfill excavation, upon which the Contractor's Geotechnical Engineer has made sufficient tests and observations to enable them to issue a written statement that, in their opinion, the fill has been placed and compacted in accordance with the requirements of these specifications.

K. Underslab Gravel: Imported Class 6 road base per Colorado Department of Transportation Standard Specifications for Road and Bridge Construction (current addition) or material approved by the Contractor's Geotechnical Engineer.

L. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 3/4 cu. yd. for footing, trench, and pit excavation which in the Contractor's Geotechnical Engineer's opinion cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.

2. Structures: Buildings, footings, foundations, slabs, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

M. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base course, drainage fill, or topsoil materials.

N. Utilities: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Material Test Reports: Provided by Contractor from an independent qualified materials testing agency indicating and interpreting test results for compliance of the following with requirements indicated. Test reports shall be current to within 12 months of scheduled construction activities.

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.

2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

3. Aggregate base course quality and gradation test results as specified in section 703 of the CDOT Specifications for Road and Bridge Construction.

1.5 QUALITY ASSURANCE

A. Comply with applicable codes, ordinances, regulations, references and standards in effect at bid date:

1. Uniform Building Code (UBC) or International Building Code (IBC) per jurisdiction criteria.

2. American Society for Testing and Materials (test methods as specified hereafter)(ASTM).

3. State and local codes.

B. In case of conflict between the above codes, regulations, references and standards and these specifications, the more stringent requirements shall govern.

C. Testing Agency: The Contractor will employ a qualified independent materials testing agency. Contractor shall furnish testing agency access to work, facilities and incidental labor required for testing. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing. All test reports shall be provided to the Contracting Officer.

D. Geotechnical Engineer: All materials and operations under this section of the specifications shall be executed under the observations of a Geotechnical Engineer hired and paid by the Contractor who will place qualified personnel on the site during earth moving operations as necessary.

The Contractor's Geotechnical Engineer shall approve all foundation excavations and give written acceptance of the completed subgrade to the Contracting Officer at the following times:

1. During the removal and replacement of existing fill materials and the removal of other deleterious materials.

2. During the processing and mixing of existing asphalt and concrete pavement materials with satisfactory materials. The Contractor's Geotechnical Engineer shall observe and approve the quantities being mixed prior to placement and compaction of material throughout the site.

3. When excavations are first open.

4. Just prior to placing of aggregate base course, or asphalt and concrete pavements, shall test and control the fill compaction, approve the materials and method of placing and compacting and give written approval to the Contracting Officer that all bearing surfaces and fill requirements have been satisfied.

5. The Contractor shall be responsible to notify the Contracting Officer when tests are to be made.

E. For approval of imported or on-site fill material, notify the Contracting Officer at least ten (10) working days in advance of intention to import material, designate the proposed borrow area and permit the Contractor's Geotechnical Engineer to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material. The Contractor's Geotechnical Engineer report on the acceptability of imported materials shall be final and binding. Any materials imported to the site prior to acceptance of the Contracting Officer shall be removed at no additional cost to the Government.

F. Reference Standards:

Compaction Standard: Standard Proctor Density ASTM D698.

G. Preconstruction Conference: Conduct conference at Project site as directed by the Contracting Officer prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locations, sizes and depths or invert elevations of existing utilities as shown on the drawings are based on information provided by others, and are believed to be correct, but may not be absolutely so. Such information is therefore presented only as approximations, and should be verified prior to construction. Protect from damage any sewer, water, gas, electric, phone or other pipe lines or conduits uncovered during the work until they have been examined by the Contracting Officer. If such lines are found to be abandoned and not in use, remove affected sections without extra cost. If such lines are found to be in use, carefully protect and carry on work around them. If the Contracting Officer deems it advisable to move such lines, the Government will pay cost of moving. Do not interrupt utilities serving facilities occupied by the Government or others unless permitted in writing by the Contracting Officer and then only after arranging to provide temporary utility services according to requirements indicated.

1. Contact utility-locator service for area where project is located before excavating.

2. Notify the Contracting Officer not less than seven (7) days in advance of proposed utility interruptions.

3. Do not proceed with utility interruptions without the Contracting Officer's written permission.

B. Demolish and completely remove or abandon existing underground utilities indicated to be removed or abandoned in place. Coordinate with utility companies to shut off services if lines are active. Refer to Division 31 Section "Site Clearing" for additional requirements.

C. Remove all existing fill deemed to be unsatisfactorily placed by the Contractor's Geotechnical Engineer.

D. Existing Contours and Elevations: Contours and spot elevations of existing ground elevations at the site, and approximate elevations of finish grade cuts, fills, and excavations for the Work are shown on Drawings. Contours and elevations for existing ground lines are based on information provided by others and are believed to be correct, but may not be absolutely so. Existing contours and elevations should therefore be considered approximate and should be verified at the site prior to construction.

E. Verification of Existing Conditions: Visit the site prior to submission of bids. Verify existing conditions, elevations, and contours. In the event of discrepancies between existing conditions and those indicated on the Contract Documents or survey, contact the Contracting Officer for clarification.

F. Existing Benchmarks: Carefully preserve and maintain existing benchmarks, monuments, property line pins, and other reference points. If disturbed or destroyed, restore or replace by a Professional Land Surveyor at no additional cost to the Government.

G. Frost Protection: When freezing temperatures may be expected, do not excavate to the full depth indicated unless the footing or slabs are to be poured immediately after the excavation has been completed. If placing of concrete is delayed, protect the bottoms of excavations from frost until concrete is placed.

1.7 WARRANTY

A. Settlement in backfill, fill or in structures built over backfill or fill, which may occur within the specified project warranty period, shall be corrected at no cost to the Government. Any structures damaged by settlement shall be restored to their original condition by the Contractor, at no cost to the Government.

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: Shall meet approval of the Contractor's Geotechnical Engineer and shall be free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Clean, on-site, natural soils, or imported materials, as approved by the Contractor's Geotechnical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups include GP, SP, CH, MH, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups, as identified by the Contractor's Geotechnical Engineer.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Satisfactory on-site soils free of debris, vegetation, organics, frozen material, and other deleterious materials. Soils shall be free of particles larger than 3 inches

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand satisfying the properties of Class 6 aggregate base course in accordance with the quality and gradation requirements specified in Section 703.03 of the CDOT Specifications for Road and Bridge Construction, current edition.

F. Engineered Fill:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
On-site sand and gravel soils	SM, SC, GC-GM	On-site sand and gravel soils are considered suitable for reuse as compacted fill below foundation, slab, and pavement areas and as general backfill for this project.
On-site clay soils mixed with sand and gravel soils[3]	CL	On-site clay soils mixed with sand and gravel soils are considered suitable for reuse as compacted fill below foundation, slab, and pavement areas and as general backfill for this project.
Processed Demolition Debris (asphalt and concrete)	-	Properly processed asphalt and concrete is considered suitable for reuse as compacted fill below foundation, slab, and pavement areas, provided the materials are processed and blended with on-site soils.
Imported soils	Varies	Imported soils meeting the gradation outlined herein can be considered acceptable for use as engineered fill beneath slabs and pavements.

1. Controlled, compacted fill shall consist of approved materials that are free of organic matter and debris. Frozen material shall not be used, and fill shall not be placed on a frozen subgrade. A sample of each material type shall be submitted to the Contractor's Geotechnical Engineer for evaluation.

2. Care shall be taken during the fill placement process to avoid zones of dis-similar fill. Improvements constructed over varying fill types are at a higher risk of differential movement compared to improvements over a uniform fill zone.

3. On-site clay soils shall be mixed with on-site sand and gravel soils to meet the gradation requirements outlined below for imported soils.

4. Demolition debris (asphalt and concrete) shall be processed to maximum individual particle size of 3 inches and blended with on-site soils prior to re-use at a ratio of 50 percent asphalt or concrete debris to 50 percent soil.

Imported soils for engineered fill shall meet the following material property requirements:

Gradation	Percent Finer by Weight (ASTM C136)
3”	100
No. 4 Sieve	50-100
No. 200 Sieve	<35

- Liquid Limit ..... 30 (max)
- Plasticity Index ..... 15 (max)
- Maximum Expansive Potential (%) 0.5*

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at optimum water content. The sample shall be confined under a 200-psf surcharge and submerged.

G. Bedding Course: As specified in Division 31 Section “Trenching and Backfilling”.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1 ½-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Drainage Fill: Material meeting a CDOT Class 6 aggregate base or equivalent per CDOT Specifications for Road and Bridge Construction, current edition, Section 703 Table 703-2.

2.2 GEOTEXTILES

A. Subsurface Drainage and Separation 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. Utilize Mirafi 140N or equal.

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. Preparation of subgrade for earth moving operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 01 Section "Temporary Erosion and Sediment Control," during earth moving operations. 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 rights-of-way.

D. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

E. Cold Weather Work: Prevent frost from entering bearing stratus upon which construction will take place or in areas where fill will be placed in that season.

3.2 DEWATERING

A. Prevent surface water and subsurface ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. 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.

2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

    a. Groundwater and stormwater shall be pumped, piped, removed and disposed of in a manner which does not cause flooding of existing streets nor erosion on abutting properties.

3. Obtain and comply with all provisions of the Colorado Department of Public Health and Environment, Water Quality Control Division, Construction Dewatering Permit. Contractor to coordinate with the Government after award on obtaining the permit.

C. Protection of Persons and Property:

1. Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the Work, as required by municipal or other authorities having jurisdiction.

2. Protect adjacent streets, roadways, and properties throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, sidewalks, pavements, and other improvements from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: All excavation (other than rock excavation) is considered as unclassified and is defined as removal of all material encountered, regardless of soil type. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include soil materials, and obstructions. Unclassified excavation is considered normal excavation and no extra costs will be allowed.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

2. Remove material of every nature or description encountered in obtaining required lines and grades. Excavate and/or place and compact fill to provide for building pad elevation(s) required by drawings.

3. Excavate wide enough at foundations and retaining walls to permit erection and removal of forms, application of dampproofing or waterproofing.

4. Pitch grading around excavations to prevent water from running into excavated areas.

5. Pre-rip hardpan and soft bedrock with single-tooth ripper or other suitable equipment to facilitate excavation with conventional earth-moving equipment.

6. Bearing soils disturbed by excavating equipment must be recompacted to 98 percent of maximum Standard Proctor Density (ASTM D698) prior to placing concrete.

7. Exposed areas which will receive fill once properly cleaned, shall be scarified to a minimum depth of 12-inches, conditioned to near optimum moisture content, and compacted.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth excavation and rock excavation. Do not excavate rock until it has been classified and confirmed the Contracting Officer.

1. 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 other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

C. Stability:

1. Slope sides of excavations in compliance with OSHA requirements and local codes or ordinances. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

2. Continuously monitor cut slopes for distress. Take all necessary precautions to safeguard workers, structures, and utilities.

3. Provide all necessary shoring, sheeting, or bracing of sides of excavations required to prevent caving, erosion, and gullying. Provide underpinning of existing structures or other improvements adjacent to excavations which are subject to damage.

D. Unanticipated Conditions: Notify the Contracting Officer immediately upon finding evidence of previous structures or filled materials which penetrate below designated excavation levels, groundwater or water-bearing strata, or other conditions which are not shown or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Contracting Officer's instruction before proceeding with further work in such areas.

E. Rock Excavation: Includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction. Rock excavation in unconfined areas is defined as removal and disposal of material which in the Contractor's Geotechnical Engineer's opinion, cannot be excavated without continuous and systematic drilling and blasting, or continuous use of a suitable ripper or other special equipment.

1. Unanticipated Rock Excavation: Rock excavation that is not indicated on existing surveys or which cannot be reasonably assumed from geotechnical studies of the site and which could not have been anticipated without extensive investigations. Unanticipated rock excavation shall be subject to change order procedures or previously agreed upon unit prices.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10-foot. If applicable, extend excavations a sufficient distance from structures for

placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Remove existing undocumented fill material down to native soils and laterally beyond all edges of the footings at least 8-inches per foot of over excavation depth below footing base. Replace with properly moisture conditioned and compacted fill as approved by the Contracting Officer. 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 Below Slab on Grade: Remove existing undocumented fill material within the proposed footprint of the building slab-on-grade as recommended by the Contractor's Geotechnical Engineer in the field and replace with engineered fill materials as approved by the Contractor's Geotechnical Engineer. The Contractor's Geotechnical Engineer shall observe removal of fill materials and provide written approval of subgrade condition prior to placement of engineered fill.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Remove existing undocumented fill material within limits of proposed pavements as recommended by the Contractor's Geotechnical Engineer in the field and replace with engineered fill materials as approved by the Contractor's Geotechnical Engineer.

C. In areas where no undocumented fill is present, scarify subgrade soils beneath exterior slabs, sidewalks and pavements to a minimum depth of 12-inches, moisture condition and recompact as specified.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Refer to Division 31 Section "Trenching and Backfilling," for excavating and backfilling of utilities.

3.8 SUBGRADE INSPECTION

A. Notify the Contractor's Geotechnical Engineer when excavations have reached required subgrade.

B. If the Contracting Officer and Geotechnical Engineer 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 heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Remove and replace soft areas. 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.

2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Contractor's Geotechnical Engineer and approved by the Contracting Officer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Contracting Officer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by the Contracting Officer. If approved by the Contracting Officer, engineered fill placed at 100 percent ASTM D698, 2 percent below to 1 percent above optimum moisture may be used.

1. Fill unauthorized excavations under other construction or utility pipe as directed by the Contracting Officer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials in approved locations 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.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, 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.

8. Acceptance of subgrade by the Contractor's Geotechnical Engineer.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Refer to Division 31 Section "Trenching and Backfilling," for excavating and backfilling of utilities.

3.13 SOIL FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

1. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

2. In areas of fill, scarify natural soil following removal of unsatisfactory material, to a depth of 12-inches.

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 engineered fill or reconditioned on-site soils or imported fills as approved by the Contractor's Geotechnical Engineer.

4. Under building slabs, use engineered fill or reconditioned on-site soils or imported fill as approved by the Contractor's Geotechnical Engineer.

5. Under footings and foundations, use engineered fill or reconditioned on-site soils or imported fill as approved by the Contractor's Geotechnical Engineer.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to optimum or to 2 percent over optimum moisture content for clay soils mixed with on-site sand and gravel soils, or within 2 percent of optimum moisture content for granular soils.

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 beyond the tolerances described above and is too wet to compact to specified dry unit weight.

3. Engineered fill shall be tested for water content and compaction during placement. If the results of the in-place density tests indicate the specified water or compaction limits have not been met, the area represented by the test shall be reworked and retested as required until the specified water and compaction requirements are achieved.

4. Water levels shall be maintained low enough to allow for satisfactory compaction to be achieved without the compacted fill material pumping when proofrolled.

5. Moisture conditioned clay soils shall not be allowed to dry out. A loss of moisture within these materials could result in an increase in the materials expansive potential. Subsequent wetting of these materials could result in undesirable movement.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 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.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under exterior flatwork, slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 98 percent.

2. Underfootings and interior floor slabs, excavate to approved natural soils, in fill condition, compact to 98 percent.

3. Under lawn or unpaved areas within 10 feet of buildings, scarify and recompact top 12 inches below subgrade and compact each layer of backfill or fill soil material at 98 percent.

4. Under lawn or unpaved areas not within 10 feet of buildings, scarify and recompact top 12 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.

5. Compact foundation wall backfill to 98 percent.

6. Compact scarified subgrade soils to 98 percent.

3.16 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.

B. Site 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 feet.

2. Walks: Plus or minus 0.10 feet.

3. Pavements: Plus or minus 0.10 feet.

4. Grading inside Building Lines: Finish subgrade to a tolerance of ½-inch when tested with a 10-foot straightedge.

3.17 BASE COURSES

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements as follows:

1. Install separation geotextile , if recommended by the Contractor’s Geotechnical Engineer and approved by the Contracting Officer, on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Place base course material over prepared subgrade and under hot-mix asphalt pavement.

3. Shape base course to required elevations and cross-slope grades.

4. Place base course 6 inches or less in compacted thickness in a single layer.

5. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

6. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

C. Gravel Maintenance Yard: Spread base course on top of existing gravel areas not being re-graded within the site to fill any existing holes and smooth out any existing ruts. Contracting Officer to advise on areas to be filled.

D. DRAINAGE COURSE UNDER SLAB-ON-GRADE

1. Place drainage course on subgrades free of mud, frost, snow, or ice.
2. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
    a. Install subdrainage geotextile if required by the Contractor’s Geotechnical Engineer on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
    b. Place drainage course 6 inches or less in compacted thickness in a single layer.

3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.18 DRAINAGE FILL FOR DRAINAGE INFILTRATION AREA

1. Place drainage fill on subgrades free of mud, frost, snow, or ice.
2. On prepared subgrade, place and compact drainage fill within the drainage infiltration area as follows:

a. Install 30 millimeter PVC impermeable liner sandwiched between subdrainage geotextile around perimeter of drainage infiltration area according to manufacturer's written instructions, overlapping sides and ends and extending a minimum of 6 inches below bottom of drainage infiltration area. Do not place on bottom of prepared drainage infiltration area as this will prevent drainage infiltration into the ground. See detail on civil drawings.
b. Place drainage fill 6 inches or less in compacted thickness in a single layer.

3. Place drainage fill that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

4. Compact each layer of drainage fill to required cross sections and thicknesses to not less than 90 percent of maximum dry unit weight according to ASTM D 698.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. 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 the Contracting Officer.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Perform field moisture tests in accordance with ASTM D3017. Tests will be performed at the following locations and frequencies at a minimum:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.

2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

E. 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 to depth required; recompact and retest until specified compaction is obtained.

3.20 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 the Contracting Officer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing at no additional cost to the Government.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to designated storage areas on off-site Government's property. Stockpile or spread soil as directed by the Contracting Officer.

1. Remove surplus satisfactory soil not to be stored on Government’s property and legally dispose of it off Government’s property.

2. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Government's property.

END OF SECTION 312000

SECTION 312333
TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Additional information concerning trenching and backfilling may be found on the civil drawings, in the project geotechnical study/report and Town of Carbondale construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning earthwork may be found in the geotechnical investigation report by Terracon Consultants, Inc. dated June 29, 2018 and clarification letter by Terracon Consultants, Inc. dated May 28, 2020. All requirements of this report shall be followed unless noted otherwise. The information shown in this report is for information and it shall be the Contractor's responsibility to field verify conditions indicated.

1.2 SUMMARY

A. This Section includes the following:

1. Excavating and backfilling for utility trenches.

2. Excavating and backfilling trenches for buried mechanical and electrical utilities.

3. Excavating and backfilling trenches within building lines.

4. Tracer wire in trenches without metal pipes.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

2. Division 31 Section "Earth Moving" for soil materials, site excavating, filling and grading.

3. Division 01 Section "Temporary Erosion and Sedimentation Control" for erosion and sediment control.

4. Divisions 22, and 26 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures, if available.

5. Division 33 Section “Water Utility Distribution Piping” for water main installation.

6. Division 33 Section “Sanitary Utility Sewerage Piping” for sanitary sewer main installation.

C. Shoring Design: Provide the services of a professional engineer to design all shoring, bracing, and underpinning required to protect the safety of workers and integrity of adjacent existing structures or other improvements.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Bedding material 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: Course placed between the subgrade and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as backfill approved by the Contractor’s Geotechnical Engineer.

E. Unclassified Excavation: Removal of all material of various characteristics required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders.

F. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed or approved by the Contracting Officer and the Contractor’s Geotechnical engineer to correct unsatisfactory conditions. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

G. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Contracting Officer. Unauthorized excavation including disposition of overexcavated materials and other work resulting from slides, cave-ins, swelling, upheaval, or remedial work, as well as remedial work directed by the Contracting Officer, shall be without additional compensation.

H. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.

I. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base course, drainage fill, or topsoil materials.

J. Utilities: Includes on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

K. Controlled Low Strength Material (CLSM): Controlled Low Strength Materials (CLSM) consists of a well-graded mixture of mineral aggregates, cementitious materials, water and admixtures. Other common names for CLSMs include: flowable fill, flowfill, non-shrink backfill, fly ash fill and controlled density fill.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.

2. Tracer wire to be installed.

B. Samples: Contractor to submit representative samples of all materials proposed for use in bedding and trench backfilling operations to the testing and inspections agency for analysis and determination of compliance with the requirements specified herein.

C. Material Test Reports: Provided by Contractor from an independent qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated. Test results shall be current to within 12 months of scheduled construction.

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.

2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

3. Bedding material quality and gradation test results as specified in section 703 of the CDOT Specifications for Road and Bridge Construction.

D. CLSM: The Contractor is required to submit a mix design and test data for approval, prior to excavating the area for which CLSMs are proposed for use. All materials of this category placed without previous approval, or which do not perform as specified, will be rejected by the Government and all costs incurred for removal and replacement of these materials will be at the Contractor's expense.

1.5 QUALITY ASSURANCE

A. Testing Agency:

1. All testing and inspections required herein will be performed by an independent testing and inspection agency employed by the Contractor.

2. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing or inspection services.

3. All test reports shall be provided to the Contracting Officer.

B. Regulatory Requirements: Comply with all applicable requirements of the Occupational Safety and Health Administration and local and State rules, regulations, and ordinances concerning shoring, bracing, or sloping of excavations and safety of workers. Safety of workers is the responsibility of the Contractor.

C. Coordination: Coordinate scheduling and procedures for trench excavation, bedding, and backfilling with other Sections whose work relates to or is affected by this work.

D. Pre-Construction Conference: Conduct conference at Project site as directed by the Contracting Officer prior to start of construction. Contractor to comply with requirements, which also may be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locations, sizes and depths or invert elevations of existing utilities as shown on the drawings are based on information provided by others, and are believed to be correct, but may not be absolutely so. Such information is therefore presumed only as approximations and should be verified prior to construction. Do not interrupt utilities serving facilities occupied by the Government or others unless permitted in writing by the Contracting Officer and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify the Contracting Officer not less than seven (7) days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without the Contracting Officer's written permission.

3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove or abandon existing underground utilities per Division 31 Section "Site Clearing."

C. Existing Bench Marks: Carefully preserve and maintain existing bench marks, monuments, property line pins, and other reference points. If disturbed or destroyed, restore or replace them by a registered land surveyor at no additional cost to the Government.

D. Verification of Existing Conditions: Visit the site prior to submission of bids. Verify existing conditions, elevations, and utility locations. In the event of discrepancies between existing conditions and those indicated on the Contract Documents or survey, contact the Contracting Officer for clarification.

1.7 WARRANTY

A. Settlement in backfill, fill or in structures built over backfill or fill, which may occur within the specified project warranty period, shall be corrected at no additional cost to the Government. Any structures damaged by settlement shall be restored to their original condition by the Contractor, at no additional cost to the Government.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Utility Trench Bedding Materials:

1. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand satisfying the properties of Class 6 aggregate base course in accordance with the quality and gradation requirements specified in Section 703.3 of the CDOT Specifications for Road and Bridge Construction, current edition.

   In the event the excavation or overexcavation for bedding is below the water table, the sub-bedding material shall consist of ¾-inches to 1-1/2-inches rock (or larger if approved), placed in accordance with the recommendations of the Contractor's Geotechnical Engineer and with the approval of the Contracting Officer.

2. Agency Requirements: Bedding requirements shall be in accordance with jurisdiction having control over utility.

B. Utility Trench Backfill Materials:

1. Existing satisfactory soils obtained from trench excavations, including granular or aggregate base course from removed pavements, broken and pulverized claystone or claystone-sandstone bedrock may be used for backfilling trenches, provided it meets any special requirements of the Utility Agency and the Contractor's Geotechnical Engineer. Bedrock must be processed and broken or pulverized so that the maximum particle or fragment size does not exceed three-inches (3-inches).

C. Unsuitable Utility Trench Materials: Materials unsuitable for bedding and backfilling include highly organic soils, ASTM D2487 Group PT topsoil, and soils containing roots, vegetable matter, trash, and debris.

2.2 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Controlled Low Strength Material: Self compacting, flowable concrete material produced from the following:

1. Portland Cement: ASTM C 150, Type II minimum 50 lbs/cu. yd. Per CDOT Standard Specifications Section 206.

2. Fly Ash: ASTM C618, Class C or F. Can be substituted up to 40% of weight of Portland Cement.

3. Coarse Aggregate: In accordance with the grading and quality requirements of AASHTO M 80, Class A, except that the percentage of wear shall not exceed 45 when tested in accordance with AASHTO T 96.

4. Fine Aggregate: In accordance with the grading and quality requirements of AASHTO M 6, Class A. The minimum sand equivalent, as tested in accordance with Colorado Procedure 37 shall be 80. The fineness modulus, as determined by AASHTO T 27, shall not be less than 2.50 or greater 3.50.

5. Foaming Agent: ASTM C 869.

6. Water: ASTM C1602.

7. Air-Entraining Admixture: AASHTO M 154.

8. Admixtures: Chemical admixtures for concrete shall conform to the requirements of AASHTO M 194. Admixtures shall be compatible with the cement and other admixtures.

B. Produce low-density, controlled low strength material with the following physical properties:

1. Total cementitious material: 50 to 95 lb/cy.

2. Fly Ash by Weight: Maximum 40% of total cementitious materials.

3. Air-entrained to total air content: 4% to 8%.

4. The mix shall have a slump between 7 and 10 inches as per ASTM C 143.

5. Fine Aggregates: Between 50% and 60% by volume of total aggregate.

6. Compressive strength at 28 days: 50 to 150 psi when molded and cured in accordance with ASTM D 4832.

7. Maximum water-cement ration: 3.5:1.

2.3 ACCESSORIES

A. Shoring and Bracing: Provide all materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross-braces, in good and serviceable condition, as required for safety and by governing authorities.

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils 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 or Dark Gray: Sewer systems.

C. Tracer Wire: Insulated no. 12 type UF tracer wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 01 Section "Temporary Erosion and Sediment Control," during earthwork operations.

D. Existing Utilities:

1. General: Location of existing utilities shown on the plans are approximate only. The Contractor shall be responsible to locate all existing underground utilities in areas of the work. If utilities are to remain in place, provide protection during excavation and backfilling operations. Should uncharted or incorrectly charted piping or other utilities be encountered during excavations, consult the Contracting Officer immediately for direction. Cooperate with the Utility Agency in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the Utility Agency or the Contracting Officer.

2. Active Utilities: Do not interrupt existing utilities serving facilities occupied and used by the Government or by adjacent properties, except when permitted in writing by the Contracting Officer, and then only after acceptable temporary utility services have been provided. Remove or relocate utilities only as indicated or specified.

3. Inactive Utilities: Report inactive or abandoned utilities encountered in excavating or grading operations, and remove, plug, or cap as required. In the absence of specific requirements, plug or cap such utility lines at least 5-feet -0-inches outside new building walls, or as required by local requirements.

4. Removal: Demolish and completely remove or abandon from the project site all existing underground utilities per Division 31 Section “Site Clearing.”

E. Protection of Persons and Property:

1. Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.

2. Protect adjacent streets, structures, and other improvements from damage caused by settlement, undermining, washout, and other hazards created by trench excavations.

F. Protect subgrades and trench bottoms soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

G. Cold Weather Work: Prevent frost from entering bearing strata upon which construction will take place or in areas where fill will be placed in that season.

3.3 DEWATERING

A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. 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.

2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

a. Groundwater and stormwater shall be pumped, piped, removed and disposed of in a manner which does not cause flooding of existing streets nor erosion on abutting properties.

3. Obtain and comply with all provisions of the Colorado Department of Public Health and Environment, Water Quality Control Division, Construction Dewatering Permit. Contractor to coordinate with the Government after award on obtaining the permit.

3.4 SHORING AND BRACING

A. Provide shoring and bracing of excavations as required for safety and by governing authorities. Carry down shoring and bracing as excavation progresses. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

3.5 PAVEMENT REMOVAL AND REPLACEMENT

A. Where trenches or other utility excavations are made in existing paved areas, saw-cut pavement surface to create a clean break line.

1. Asphalt and bituminous pavements to be cut to the full depth of pavement. The vertical face of the cut shall be a straight line parallel to the limit of excavation.

Cuts shall be made with a flat-bladed air hammer, concrete saw, or as approved by the authority having jurisdiction. The method used shall provide a straight, true cut. All asphalt within trench limits to be hauled of site.

2. Concrete pavements, including curbs, gutters, and sidewalks, to be saw cut to the full depth of pavement at the nearest construction joint. The vertical face of the cut shall be a straight line parallel to the limit of excavation.

3. All pavement removal shall be disposed of off site. Broken pavement shall not be used in backfill material.

B. After trench has been backfilled and compacted, place new pavement in accordance with applicable requirements of Division 32 Sections as applicable, for Asphaltic or Portland cement concrete pavement and in accordance with Authorities having jurisdiction.

3.6 EXPLOSIVES

A. Explosives: Do not use explosives.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following 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, unless otherwise indicated on the drawings.

C. Clearance: Minimum trench width shall be the outside diameter of the pipe or conduit plus 16-inches.

1. Slope sides of trenches or provide shoulders in accordance with OSHA requirements and as required by Utility Agency standards.

2. Continuously monitor cut slopes and trenches for distress or movement. Provide all necessary shoring and bracing required to protect the life and safety of workmen performing excavation or installing piping or conduit.

D. Trench Bottoms: Excavate trenches a minimum of 6 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course and backfill with a 6-

inch layer of crushed stone or gravel with filter fabric installed around it to mitigate migration of fines prior to installing pipe.

3.8 BEDDING OF PIPES:

A. After completion of trench excavation and before installation of piping, install not less than 6-inches of approved bedding material in trench bottom for support of pipe. Dig bell holes in bedding deep enough to provide a minimum of 2-inches clearance between the bell and bedding material. Fully support pipe on bedding material for the full length of the pipe barrel.

B. After pipe is adjusted for line and grade, and all jointing is complete, carefully place and tamp bedding material under the haunches of the pipe and in the previously dug bell holes.

C. Install bedding to a minimum depth of 12-inches above top of pipe prior to starting placement of compacted backfill. Lightly compact or tamp bedding material in a manner to avoid displacement of or damage to the pipe.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials in approved locations 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 on the upgradient side. Do not store within drip line of remaining trees.

3.10 UTILITY TRENCH BACKFILL

A. After installation of utility piping or lines have been completed, locations recorded, trash or other debris removed from excavations, and bedding placed and approved, backfill promptly as work and weather conditions permit. Do not backfill trenches until all required pipe system tests and inspections have been made, unless partial backfilling is required to restrain pipe under test pressures. Use care in backfilling to avoid damage or displacement of pipe systems.

B. Install tracer wire on top of pipes by taping or using plastic ties. The wire shall be fastened to the pipe with tap or plastic ties at 5 foot intervals.

1. Sanitary: Install at grade tracer wire access point directly above sewer service at property line. Install a ground rod to the side of the sewer service at the property line. Coil up to 1 foot of extra red and green wire in access point. Red wire is from ground rod and green wire is tracer wire on service pipe.

2. Water: Tracer wire shall be looped up to each fire hydrant. A cathodic protection box shall be set on the right hand side of each hydrant. The box shall have a cast iron

locking lid ith a three and one-half inch diameter, eighteen inch long PVC body. The cap will need a two-wire connection post as a minimum.

C. Place bedding materials on subgrades free of mud, frost, snow, or ice.

D. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

E. Place backfill materials in layers not more than 8-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. Use hand held tools or compacting devices for trench backfill, until a minimum compacted thickness of 3-feet -0-inches above top of pipe is achieved. Mechanical or power compactors may be used thereafter.

F. Before compaction, moisten or aerate each layer of backfill to within 2% of optimum moisture content.

G. Compact each layer to not less than 98% of maximum standard Proctor density (ASTM D698). Thoroughly compact by means of mechanical tampers areas which cannot be properly compacted by means of rolling equipment.

H. Backfill to subgrade elevation shown for finish grading, topsoil placement, or paving.

I. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches above the bedding course.

1. Carefully compact initial backfill along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

J. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

K. Place and compact final backfill of satisfactory soil to final subgrade elevation.

L. Install warning tape directly above utilities, 12 inches below finished grade, and 6 inches below subgrade under pavements and slabs.

M. Controlled Low Strength Material: Place initial backfill of controlled low strength material to a height of 12 inches over the bedding course. Coordinate backfilling with utilities testing.

N. Controlled Low Strength Material: Place final backfill of controlled low strength material to final subgrade elevation.

O. When CLSMs are placed within the right-of-way, or they are to be covered by paving materials, the final set product must achieve a maximum indentation diameter of 3

inches prior to covering and opening the area to traffic. Penetration resistance shall be as measured by ASTM C6024, “Standard Test Method for Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application”.

P. CLSM must be placed in a uniform manner that will prevent voids or segregation of the backfill and shifting of pipelines, structures and appurtenances. Foreign material that falls into the trench prior to, or during placement shall be immediately removed.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage an independent qualified materials testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Perform field moisture tests in accordance with ASTM D3017. Tests will be performed at the following locations and frequencies at a minimum:

1. Trench Backfill: The density tests shall be performed during backfilling at specified depths in the trench to ensure that the required density and moisture is obtained throughout. For trenches less than 30-inches in depth, density tests shall be taken within 18-inches above the top of pipe or conduit and at the surface/toplift as a minimum. For trenches greater than 30-inches in depth, density tests shall be taken within 18-inches of the top of the pipe or conduit, and at 2-foot vertical intervals to the top of the trench with the final test at the surface/toplift. For utility mains conduct one (1) set of tests per 100 feet of linear trench at specified depths and for service lines conduct one (1) test per every service line per utility type at specified depths. At a minimum, test intervals and quantities shall meet or exceed the requirements of the local utility agency.

D. When testing agency reports that backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.12 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 the Contracting Officer; reshape and recompact.

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.

3.13 CLEANING AND ADJUSTMENT

A. Cleanup: Remove excess materials not required for backfilling purposes, including excess spoil material, accumulated debris, and rubbish from site. Burning of waste material is prohibited.

3.14 RESTORATION

A. Adjacent Improvements: Restore all fences, irrigation ditches, yards, lawns, and other structures or surfaces to condition equal to or better than before work began.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to designated storage areas on off-site Government's property. Stockpile or spread soil as directed by the Contracting Officer.

1. Remove surplus satisfactory soil not to be stored on Government’s property and legally dispose of it off Government’s property.

2. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Government's property.

END OF SECTION 312333

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.

B. Additional information concerning asphalt paving may be found on the civil drawings, in the project geotechnical report and Town of Carbondale construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning asphalt paving may be found in the geotechnical investigation report by Terracon Consultants, Inc. dated June 29, 2018 and in the clarification letter by Terracon Consultants, Inc. dated May 28, 2020. The recommendations provided in this report are for information and it shall be the Contractor's responsibility to field verify conditions indicated.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.

2. Hot-mix asphalt patching.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling and site grading.

2. Division 32 Section "Pavement Markings" for pavement striping and symbols.

C. References:

1. Town of Carbondale Public Works Manual, 2009.

2. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition and all appropriate standard special provisions.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. CDOT: State of Colorado Department of Transportation.

C. CDOT Specifications: Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition and all appropriate standard special provisions.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving in accordance with Section 401 of the CDOT Specifications.

1. Standard Specification: CDOT Specifications.

2. Measurement and payment provisions and safety program submittals included in CDOT Specifications do not apply to this Project.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated, include technical data and tested physical and performance properties.

B. Job-Mix Designs: For each job mix proposed for the Work. Job mixes shall be tested and produced within 12 months of scheduled paving operations.

C. Material Test Reports: For each paving material. Test reports shall be current to within 12 months of scheduled paving operations.

D. Material Certificates: For each paving material, signed by providers.

1.6 QUALITY ASSURANCE

A. Manufacturer and Installer Qualifications:

1. 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 for the region specified.

2. 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 for the region specified.

B. Testing Agency:

1. All testing and inspections required herein will be performed by an independent materials testing and inspection agency employed by the Contractor.

2. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing or inspection services.

C. Testing Requirements: Asphalt Paving shall be tested for gradation, asphalt content and in-place density in accordance with CDOT Specifications, the current edition of CDOT Field Materials Manual, and local Regulatory Agency requirements, whichever are the most stringent.

D. Preconstruction Conference: Conduct conference at Project site as directed by the Contracting Officer. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Tack Coats: Minimum surface or air temperature in the shade of 60 deg F.

2. Asphalt Base Course: Minimum surface or air temperature in the shade of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface or air temperature in the shade of 50 deg F and rising at time of placement.

B. Coordination and Scheduling:

1. Coordinate with other trades and arrange scheduling to avoid damage to other work, including grading, site utilities and piping, exterior concrete, landscaping and irrigation systems.

2. Before commencing pavement operations, ascertain that utility lines, site lighting and wiring, piping, curb and gutter work, general grading and heavy trucking is complete so that such operations will not damage paving work.

3. Mask off and protect exposed building surfaces and abutting concrete from damage or staining by tack coat and paving operations.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations meeting the requirements of the CDOT Specifications.

B. Asphalt Concrete Aggregate: Clean, hard, durable particles of crushed stone, crushed slag, crushed gravel, or natural gravel conforming to the quality and gradation requirements of Subsection 703.04 of the CDOT Specifications and Grading SX and S (Table 703-4).

C. Mineral Filler: Rock dust, slag dust, hydrated lime, hydraulic cement, or other suitable mineral material conforming to the requirements of Subsection 703.06 of the CDOT Specifications.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: The asphalt cement to be used on this project shall be PG 64-22 conforming to the requirements of Subsection 702.01 and Table 702-1 of the CDOT Specifications.

B. Tack Coat: AASHTO M 140, emulsified asphalt or AASHTO M 208, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Water: Potable.

2.3 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes. Furnish job-mix formulas for each pavement type, conforming to the requirements of Subsection 401.02 of the CDOT Specifications. Mix aggregates and bituminous materials in accordance with the requirements of Subsection 401.15 of the CDOT Specifications. Use approved job mix formulas. Mix to comply with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

2. Base Course: Grading S (3/4” nominal).

3. Surface Course: Grading SX (1/2” nominal).

B. Emulsified-Asphalt: Shall conform to AASHTO M140 or M208 in accordance with Subsection 702.03 of the CDOT Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is unfrozen, free of water, snow, and ice and is otherwise in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction. Scarify, regrade and recompact surface of subgrade that is pumping or deforming as required to provide true levels, uniform slopes and proper total thickness of paving as required in Division 31 Section “Earth Moving.”

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

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Asphalt and bituminous pavements to be cut to the full depth of pavement. The vertical face of the cut shall be a straight line parallel to the limit of excavation. Cuts shall be made with a flat-bladed air hammer or concrete saw. The method used shall provide a straight, true cut. All asphalt within trench limits to be hauled of site. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.2 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 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.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.20 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt 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 on the plans or as directed by the Geotechnical Engineer. Maximum lift thickness shall be 3-inches. Minimum lift thickness shall be 1½-inches for Grading SX and 2.25-inches for Grading S.

2. Place hot-mix asphalt surface course in single lift. Maximum lift thickness shall be 2-inches.

3. Spread mix at minimum temperature of 235 deg Fin accordance with Subsection 401.15 of the CDOT Specifications, Table 401-5.

4. Begin applying mix 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 wide unless 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 a section of asphalt base course 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. Place hot-mix asphalt edge treatment where indicated and as shown on the construction documents.

3.5 JOINTS

A. Construct joints to ensure a 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 to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, 6 to 12 inches.

4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."

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.

3.6 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. When paving surface temperature falls below 185 deg F no further compaction effort will be permitted unless approved.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated grade and smoothness. Correct laydown and rolling operations to comply with requirements.

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 the following density in accordance with Subsection 401.17 of the CDOT Specifications.

1. Pavement shall be compacted to a density of 92% to 96% of the maximum theoretical density, determined according to Colorado procedure 51. Field density determination will be in accordance with Colorado Procedure 44 or 81.

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 asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. 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.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus ¼ inch.

2. Surface Course: Plus ¼ inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: ¼-inch.

2. Surface Course: $^{3}/_{16}$-inch.

3.8 MANHOLE FRAME ADJUSTMENTS

A. Set frames for manholes and other utility structures within areas to be paved to ¼-inch minimum to ½-inch maximum below final grade as part of this work. Include existing frames or new frames furnished under other sections of these specifications.

B. Set cover frames to ¼-inch minimum and ½-inch maximum below surface of adjacent pavement. Surround frames set to grade with a ring of compacted asphaltic concrete base prior to paving. Place asphaltic concrete mixture up to 1-inch below top of frame, slope to grade, and compact with hand tamping. Adjust frames as required for paving.

C. Provide temporary closures over openings until completion of rolling operations. Remove closures at completion of work.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent materials testing and inspecting agency to perform field tests and inspections 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 and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional 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. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

a. One core sample will be taken for every 350 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.

b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Asphalt Content and Gradation. Testing agency will take sample of uncompacted paving mixtures at a minimum frequency of every 1,000 tons according to Colorado Procedure – Laboratory CPL-5120 and Colorado Procedure CP-31.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements. Conforming to the specified requirements will be in according with Subsection 105.03 of the CDOT Specifications.

3.10 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 321216

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.

B. Additional information concerning asphalt paving may be found on the civil drawings, in the project geotechnical report and Town of Carbondale construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning asphalt paving may be found in the geotechnical investigation report by Terracon Consultants, Inc. dated June 29, 2018 and in the clarification letter by Terracon Consultants, Inc. dated May 28, 2020. The recommendations provided in this report are for information and it shall be the Contractor's responsibility to field verify conditions indicated.

1.2 SUMMARY

A. This Section includes constructing exterior concrete paving on prepared subgrade in accordance with these specifications. This work shall be in conformity with the lines, grades, thicknesses and typical cross-sections shown on the plans for the following:

1. Driveway approaches.

2. Curbs and gutters.

3. Sidewalks, steps, and ramps.

4. Sidewalk chases and chase covers.

5. Dumpster pads.

6. Concrete subgrade for cobble sections.

7. As detailed on the plans.

B. Related Sections include the following:

1. Divisions 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.

2. Division 32 Section “Pavement Marking” for pavement striping and symbols.

3. Division 32 Section “Concrete Pavement Joint Sealants” for expansion and contraction joints.

1.3 REFERENCES

A. Town of Carbondale Public Works Manual, 2009.

B. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

B. CDOT: State of Colorado Department of Transportation.

C. CDOT Specifications: Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

D. ADA Handbook: Americans with Disabilities Act Standards for Accessible Design, U.S. Department of Justice.

E. ANSI A117.1: Standard for Accessible and Usable Buildings and Facilities, American National Standard Institute.

F. Refer to ACI 301: (American Concrete Institute – Standard Specifications for Structural Concrete), for additional definitions.

1.5 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete pavement mix, and includes alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Mix designs shall be tested and produced within 12 months of scheduled paving operations.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials. Test reports shall be current to within 12 months of scheduled paving operations.

1. Aggregates.

2. Cement.

3. Admixtures.

D. Material Certificates: Signed by manufacturers certifying that each of the following materials used in the project complies with requirements:

1. Cementitious materials and aggregates.

2. Steel reinforcement and reinforcement accessories.

3. Fiber reinforcement.

4. Admixtures.

5. Curing compounds.

6. Bonding agent or adhesive.

7. Joint fillers.

E. Field quality-control test reports.

F. Pavement Joint Layout Plan: See landscape plans for joint layout. Contractor to provide joint layout plan for concrete at new dumpster location.

G. Traffic Control Plan: For work in the public right-of-way shall be reviewed and approved by the Town of Carbondale.

H. As-Builts: Provide The Contracting Officer with copies of redlined, as-built plans upon completion of construction. Horizontal and vertical information is to be certified by a Professional Land Surveyor. As-built information should include the following at a minimum:

1. Elevations at flowline of curb and gutter at design locations and grade breaks.

2. Elevation of sidewalk chase openings and grates.

3. Any other variations from the construction documents must be clearly noted and detailed on the plans.

1.6 QUALITY ASSURANCE

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

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94/C 94 M requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mix Concrete Association's (NRMCA) Plant Certification Program.

C. Testing Agency Qualifications: An independent materials testing and inspection agency qualified according to ASTM C1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

E. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

F. Concrete Testing Service: The Contractor will engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preconstruction Conference: Conduct conference at project site as directed by the Contracting Officer prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section “Project Management and Coordination.”

H. Regulatory Requirements:

1. Comply with Town of Carbondale standards for sidewalks, curbs, ramps, gutters, and driveway approaches or aprons, including standard dimensions, profiles, thicknesses, reinforcing, and compressive strength. In the event of conflict between the Contract Documents and the standards, the more stringent requirements will apply.

2. Comply with applicable requirements of ADA Handbook, ANSI A117.1, and local and State codes and ordinances regarding walks, steps, ramps and curb ramps.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Coordination and Scheduling: Coordinate with other trades and arrange scheduling to avoid damage to other work including grading, site utilities and piping, asphalt paving, landscaping and irrigation systems.

C. Field Measurements: Verify dimensions and existing conditions shown on the drawings by taking field measurements prior to start of work. Report discrepancies to the Contracting Officer for clarification and make minor adjustments in layout as required by field conditions and as approved by the Contracting Officer, at no additional cost to the Government.

D. Environmental Requirements: Perform work only under suitable weather conditions. Comply with the environmental requirements of Section 3.6 for concrete placement.

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 Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2. Products: Subject to compliance with requirements, provide one of the products specified.

3. 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.

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

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves of a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: CDOT Section 709 and ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Epoxy Coated Reinforcement Bars: CDOT Section 709, AASHTO A775 and ASTM A 615/A 615M, Grade 60, deformed. Cut bars true to length with ends square and free of burrs.

C. Epoxy Coated Joint Dowel Bars: Plain steel bars, CDOT Section 709, AASHTO A775 and ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

D. Epoxy Coated Tie Bars: CDOT Section 709, AASHTO A775 and ASTM A 615/A 615M, Grade 60, deformed.

E. Supports for Reinforcement: Chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 EXPANSION JOINT FILLER

A. Sealed Joints: Preformed, compressible fiber or cork filler material complying with ASTM D1751 or D1752, Type II, guaranteed compatible with expansion joint sealant materials, ½-inches thick unless otherwise indicated. Provide high-impact polystyrene removable “void cap” to create ½-inches deep reveal for installation of sealant.

B. Self-Sealing Joints: Preformed, compressible asphalt fiber joint filler complying with ASTM D994, ½-inches thick unless otherwise indicated. Do not use asphalt fiber filler in joints to receive elastomeric joint sealants.

2.5 CONCRETE MATERIALS

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

1. Portland Cement: CDOT Section 701 and ASTM C 150, Type II, gray.

    a. Fly Ash: CDOT Section 701.02 and ASTM C 618, Class F.

B. Normal-Weight Aggregates: CDOT Section 703 and ASTM C 33, coarse aggregate, uniformly graded. Provide aggregates from a single source. Aggregates shall satisfy the quality and gradation requirements of CDOT 703.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal in accordance with CDOT Section 703, Table 703-1.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement and in accordance with CDOT Section 703, Table 703-1.

3. Do not use fine or coarse aggregates containing substances that cause spalling.

C. Water: CDOT Section 712 and ASTM C 94/C 94M potable.

2.6 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures. Admixtures used in the job mix shall be listed on the CDOT Approved Products List.

B. Air-Entraining Admixture: CDOT Section 711 and ASTM C 260.

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

4. Water-Reducing and Accelerating Admixture: ASTM C494, Type E.

5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

7. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.7 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

2.8 CURING MATERIALS: CDOT SECTION 711

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

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

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B.

1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

2.9 CONCRETE MIXTURES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent materials testing and inspection agency for preparing and reporting proposed mix designs for the trial batch method.

2. Do not use Government's field quality-control testing agency as the independent testing agency.

B. Proportion mixes to provide concrete with the following properties:

1. Compressive Strength (28 Days): 4,500 psi

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.44

3. Slump Limit: 4 inches.

4. Minimum 520 lb. Cement per cubic yard. (CDOT Class P)

C. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 4.0 to 8.0 percent.

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

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture, plasticizing and retarding admixture in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals as follows:

1. Fly Ash: 20percent Class F Fly Ash CDOT Section 601.02, Class P Concrete.

G. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

2.11 SIDEWALK CHASE COVER

A. Closed grate made of gray iron. Shall be ADA compliant and meet ASTM-A48 Class 35-B for heavy duty use.

1. Manufacturers:

a. Neenah Model R-4990-BX with Type D solid lid.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrade surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subgrade surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subgrade in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.

2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.

3. Subgrade with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Subgrade shall be tested by the Contractor's Geotechnical Engineer and pass required tests prior to concrete pavement placement.

D. Proceed with concrete pavement operations only after non-conforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

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 12-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Construct/install construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

2. Contractor to provide plan of joint placement for the Contracting Officer's approval.

3. The distance between joints shall not exceed in feet, twice the pavement thickness in inches. (i.e.: 6-inches PCC pavement to utilize maximum 12-foot joint spacing.)

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at expansion joints.

1. Contractor may utilize preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.

3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints in pavement every 100 feet on center and at driveways.

2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler no less than 1/2 inch or no more than 1 inch below finished surface for joint sealant.

4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

5. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Tooled Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the indicated radius. Repeat

grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subgrade 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.

D. Comply with ACI 301 and ACI 304R requirements and recommendations for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery to the project site.

F. Do not add water to fresh concrete after testing.

G. Do not add water to concrete surface during finishing operations.

H. 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.

I. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in 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 reinforcement, dowels, and joint devices.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations.

L. Curbs and Gutters: Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified with expansion joints at intervals of approximately 100 feet and tooled contraction joints at 10-foot intervals

M. Walks: Minimum 5-inches thick with fibrous reinforcement, with expansion joints at intervals of approximately 100 feet and tooled contraction joints at intervals equal to width of walks or maximum 5-foot intervals. Tool edges to rounded profile and finish as noted herein or shown on the drawings. Contractor may utilize sawed contraction joints. Place at slopes as indicated on construction drawings, but not less than 0.5%.

N. Curb Ramps: Minimum 6-inches thick with fibrous reinforcement, construct joints for ramps similar to walks. Comply with applicable ADA Handbook, ANSI A117.1, and local and State codes, ordinances, and details including maximum allowable slope not to exceed 1 foot vertical in 12 foot horizontal.

O. Steps: Minimum 6-inches thick at intersection of treads and risers, reinforced as indicated. Slope treads ¼-inches to nosing, and tool nosings to uniform ½-inches radius. Finish as specified below.

P. Chases: Minimum 6-inches thick on bottom and sides, reinforced as indicated on construction drawings. Slope longitudinally towards curb and gutter as indicated on the plans.

Q. Paving and Drain Pans: Minimum 6-inches thick unless otherwise indicated. Provide expansion joints as indicated on the drawings, and contraction joints at a minimum 12-feet -0-inches EWW. Provide fibermesh reinforcing. Place concrete paving over compacted subgrade as specified in Division 31 Section "Earth Moving". Place at slopes as indicated on construction drawings, but not less than 0.5%.

R. Driveway Approaches: Minimum 6-inches thick, unless otherwise indicated or required by local public works standards. Construct to radius of flare indicated, and taper or warp into alignment with adjacent curbs, gutters, and walks. Place approaches over compacted subgrade as specified in Division 31 section "Earth Moving." Refer to drawing and details for any reinforcing requirements.

S. Subgrade at Cobble: Minimum 4-inch thick with fibrous reinforcement, with expansion joints at intervals of approximately 100 feet and tooled contraction joints at intervals equal to width of cobble area or maximum 5-foot intervals. Tool edges to rounded profile and finish as noted herein or shown on the drawings. Contractor may utilize sawed contraction joints. Place at slopes as indicated on construction drawings, but not less than 0.5%.

T. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F 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 specified and approved in mix designs.

U. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

V. Wet-Weather Placement: Do not begin to place concrete while rain, sleet, or snow is falling unless adequate protection is provided and, when required, acceptance of protection is obtained.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

C. Float Finish: Begin the second floating operation 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. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection and follow the recommendations of ACI 305R for hot-weather protection during curing.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.

   b. Continuous water-fog spray.

   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. 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 written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 SIDEWALK CHASE GRATE

A. Assemble and install components according to manufacturer’s written instructions.

B. Set frames and grates to elevations indicated. Install with top surfaces of components flush with finished surface.

3.10 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.

2. Thickness: Plus 3/8 inch, minus 1/4 inch.

3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.

4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.

5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.

6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.

7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.

8. Joint Spacing: 3 inches.

9. Contraction Joint Depth: Plus 1/4 inch, no minus.

10. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified materials testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 50 cu. yd. or fraction thereof of each concrete mix placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each type of concrete mix. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite strength test, but not less than one test for each day's pour of each type of concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of composite strength specimens.

5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.

6. 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., provide at least two tests for every 100 cu.yd., (one set for each 50 cu. yd.). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.

7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to the Contracting Officer, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Contracting Officer, but will not be used as the sole basis for approval or rejection.

F. Additional Tests: Testing agency shall 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 the Contracting Officer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by the Contracting Officer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321316
DECORATIVE CONCRETE PAVING

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. Work includes the following and as detailed on the Drawings.

1. Pedestrian walkways

B. Related Sections:
1. Divisions 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
2. Section 321313 "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, stamped detectable warnings, pavement markings, and wheel stops.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and asphalt paving or adjacent construction.

1.3 QUALITY OF ASSURANCE

A. Refer to Town of Carbondale Standard Specifications and Special Provisions of these Contract Documents for all Concrete Paving prescribed requirements. This section only outlines Decorative Concrete Paving work specific deviations.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.5 ACTION SUBMITTALS

A. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern, or texture selection.

B. Other Action Submittals:

1. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Paving Installer.

1. Shall include company information and year in business in Roaring Fork Valley.
2. Qualifications of Foreman or Supervising Staff on Site.
3. Images of Example Projects of Similar Character at the same or similar altitude above sea level.

B. Field quality-control reports.

C. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

D. Material Test Reports: For each of the following:

1. Aggregates.

E. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

C. Preinstallation Conference: Conduct conference at Project Site.

1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and decorative concrete paving construction practices.
c. Jointing layout and control of alignment with related streetscape and building elements.

2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:

    a. Contractor's superintendent.
    b. Concrete paving subcontractor.
    c. Contracting Officer

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.9 DECORATIVE CONCRETE PAVING SCHEDULE

A. Patterned Decorative Concrete Paving Keynote 1.1

1. Locations: Install at pedestrian entry walkway, bike rack and patio
2. Coloring Method: Integrally colored.

    a. Color: Davis Colors Pebble 641, Integral Color

    b. Finish: Exposed Aggregate Finish

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less.

B. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

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

C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 CONCRETE MATERIALS

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

1. Portland Cement: ASTM C 150, white portland cement Type II.

a. Fly Ash: ASTM C 618, Class F.

B. Normal-Weight Aggregates: ASTM C 33, course aggregate, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Aggregate Size: 1-inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.

F. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

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. Davis Colors.

2.4 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

2.5 CURING AND SEALING MATERIALS

A. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C 171.

B. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B, manufactured for colored concrete.

1. For integrally colored concrete, curing compound shall be pigmented type approved by coloring admixture manufacturer.
2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

D. Clear Acrylic Sealer: Manufacturer's standard, waterborne, nonyellowing and UV-resistant, membrane-forming, medium-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 15 percent solids by volume.

E. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving surface.

2.6 RELATED MATERIALS

A. Expansion Joint Fillers: ASTM D 1752, cork or self-expanding cork in preformed strips.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. Do not use Government’s field quality-control testing agency as the independent testing agency.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4500 psi (27.6 MPa)
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.44
3. Slump Limit: 4 inches

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: 4.0 – 8.0 percent for 1-inch (25-mm) nominal maximum aggregate size.

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

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

   1. Use water-reducing admixture in concrete as required for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

   1. Fly Ash: 20percent Class F Fly Ash CDOT Section 601.02, Class P Concrete.

G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

H. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

   1. When air temperature is between 85 and 90 deg F (30 and 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.

   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

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

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

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 (50-mm) overlap to adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.

C. Expanion 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 100 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Tooled Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to the indicated radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

E. Edging: After initial floating, tool edges of paving and joints in concrete with an edging tool to the indicated radius. Repeat tooling of edges after applying surface finishes. Eliminate edging tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement**,** and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. 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.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

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 reinforcement and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 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 specified and approved in design mixtures.

K. Hot-Weather Placement: Comply with ACI 301 (ACI 301M)and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[**, steel reinforcement,**] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and 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. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.8 INTEGRALLY COLORED CONCRETE FINISH

A. Integrally Colored Concrete Finish: After final floating, apply the following finish:

1. Exposed Aggregate Finish.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Compound: Apply curing compound immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after application. Maintain continuity of coating, and repair damage during curing period.

1. Cure integrally colored concrete with a curing compound.

F. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

G. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

3.10 SEALER

A. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat using same application methods and rates.

1. Begin sealing dry surface no sooner than 14 days after concrete placement.
2. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

3.11 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Dowels: 1 inch.
5. Vertical Alignment of Dowels: 1/4 inch.
6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of dowel.
7. Joint Spacing: 3 inches.
8. Contraction Joint Depth: Plus 1/4 inch, no minus.
9. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.12 FIELD QUALITY CONTROL

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

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 50 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Decorative concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 REPAIRS AND PROTECTION

A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

C. Protect decorative concrete paving 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 decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321316

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.

B. Additional information concerning concrete paving may be found on the civil drawings, in the project geotechnical report and agency having jurisdiction construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. This Section includes the following:

1. Expansion and contraction joints within cement concrete pavement.

2. Joints between cement concrete and buildings and structures.

3. Surface preparation including primers.

4. Joint backup material.

B. Related Sections include the following:

1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 REFERENCES

A. Town of Carbondale Public Works Manual, 2009.

B. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

1.4 SUBMITTALS

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

B. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

C. 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.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

E. Warranty: As required by Division 1 – Warranty Section: Contractor agrees to repair or replace joint sealers (including labor, materials, and any necessary associated costs) which fail to perform as watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of material for exposure indicated. Provide warranty signed by Installer and Contractor.

1.5 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Work under this section shall be subject to all applicable provisions of federal, state, and local rules and regulations.

B. Applicator: Company specializing in application of sealants with five years minimum experience and be acceptable to manufacturer. Manufacturer's field representative shall visit site and make suggestions.

C. Adhesion Tests: Prior to any sealant application, perform adhesion tests as directed by sealant manufacturer's technical representative.

D. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 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 multi-component 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.

1.7 PROJECT CONDITIONS

A. Install sealant materials in strict accordance with all safety and weather conditions recommended by manufacturer, product literature, or Material Safety Data Sheets. Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed only when forecasted weather conditions are favorable for proper cure and development of high-early bond strength. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in lower third of manufacturer's recommended installation temperature range.

PART 2 - PRODUCTS

2.1 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 the Contracting Officer from manufacturer's full range.

C. Approved Sealants:

For each application, provide the grade of sealant (non-sag, self-leveling, no-track knife grade preformed, etc.) as recommended by the manufacturer for the particular condition of installation (location, joint shape, ambient temperature, and similar conditions), to achieve the best possible overall performance. Grades specified herein are for normal condition of installation.

1. Silicone Sealant: ASTM C-920-79, Type S, Class 25, Grade NS.

2.2 JOINT SEALANTS

A. Single-component formulation complying with ASTM D 6690 of D1190.

1. Refer to CDOT Standard Specification, Section 705.01 and 705.09 for joint and crack sealant material requirements.

2. Refer to CDOT Standard Specification, Section 412.18 for joint and crack sealant installation requirements.

2.3 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are non-staining; 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.

2.4 PRIMERS

A. Primers: Product recommended by join-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from manufacturers recommendation.

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

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

3.3 JOINT DESIGN

A. Sealant depth is measured at the center (thin) section of sealant bead.

B. Install sealants to depths and widths as recommended by sealant manufacturer and as shown on the drawings. Also, conform to the following general limitations if not in conflict with sealant manufacturer's recommendations.

1. For sidewalks, pavements and similar joints subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.

2. For normal moving joints not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but neither more than 5/8 inch deep nor less than 1/4 inch deep.

3. Depth of sealant must not exceed width of joint.

4. Sealant joints shall not be less than 1/4 inch in width and 1/4 inch in depth.

5. Sealant joints shall not exceed 2 inches in width in a single application.

3.4 SURFACE PREPARATION

A. Preparation work shall result in clean surfaces in all areas where sealant is to be adhered. Such surfaces shall be free of any old sealant, contaminants, and impurities, which are deleterious to bonding or adhesion of primers or sealant.

B. Clean ferrous metals of all rust, mill scale, and coatings by wire brush or grinding. Any equipment used to remove rust shall be free of oil contaminants.

C. Wire brush masonry joint surfaces, then blow clean with oil free compressed air.

D. Apply primer per manufacturer's recommendations. Allow primer to dry prior to applying sealant.

E. Do not caulk joints until they are clean, dry, and free of dust, loose mortar, old sealant, foreign matter or other bond inhibiting materials, and in compliance with requirements of manufacturer of materials, details shown on drawings, and specific requirements of other sections of specifications.

3.5 JOINT BACKING

A. Use joint backing to control depth of joint to specified thickness.

B. Select joint backing size to allow for 25 percent compression of backing when inserted into joint.

C. Where shown on drawings where depth of joint will not permit use of joint backing, or wherever recommended by sealant manufacturer, install bond-breaker tape to prevent three (3) sided adhesion.

D. Do not leave voids or gaps between ends of joint backing units.

3.6 APPLICATION/INSTALLATION OF JOINT SEALANT

A. Apply sealants neatly, in a good and workmanlike manner, which meets following minimum requirements or standards. Specific instructions of manufacturer must also be followed.

B. Apply sealant using a gun with proper size nozzles. Use sufficient pressure to fill all voids and joints solid to backup material, with complete wetting of all joint bond surfaces.

C. Applied sealant shall form a full, smooth, uniform bead, free of ridges, wrinkles, sags, air pockets and embedded impurities.

D. After joint has been completely filled with sealant, neatly tool joint sealant to eliminate air pockets, or voids, and to provide a smooth, slightly concave, neat appearing finish, with sealant surface slightly below adjoining surfaces. Wetting of finished surface will not be allowed.

E. Where horizontal joints are located between a horizontal surface and vertical surface, fill joint to form a slight cove, so joint will not trap moisture and dirt.

F. Protect adjacent surfaces and systems from sealant material. Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

G. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

H. Tooling of Non-Sag 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.

I. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

J. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.7 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.

3.8 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.

3.9 JOB SITE CLEAN-UP

A. Sealant applicator must remove all excess materials from job site.

B. Leave all surrounding areas where joint sealant has been applied free of excess sealant, debris, and foreign substances.

END OF SECTION 321373

This page intentionally left blank.

SECTION 32 1440
STONE PAVING

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. Work includes exterior stone paving including the following and as detailed on Drawings.

1. Rip-rap (Angular Flag Rock).
2. Rip-rap (Angular Flag Rock with Drain Mat).
3. Gravel Paving.

B. Related Requirements
1. Section 31 2000 “Earth Moving” for subgrade preparation and materials.
2. Section 32 1313 “Concrete Paving” for concrete subslabs.
3. Section 32 9113 “Soil Preparation” for planting soil requirements for planted joints.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of stone accessory, and manufactured product.

B. Samples for Initial Selection: For joint materials involving color selection.

C. Samples for Verification:

1. Rip-rap (angular flag rock): 1-quart volume of each; in sealed plastic bags labeled with type and source of stone paving. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture and makeup of the material.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of stone steps, boulder paving, and stone slab bridge from one quarry with resources to provide materials of consistent quality in appearance and physical properties.

1. Landscape architect to select stone paving material with contractor from supplier prior to construction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

B. Store gravel where grading and other required characteristics can be maintained, and contamination avoided.

1.7 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Stone: Obtain stone, from single quarry**,** with resources to provide materials of consistent quality in appearance and physical properties.

1. For stone types that include same list of varieties and sources, provide same variety from same source for each.

B. Varieties and Sources: Subject to compliance with requirements, provide stone of varieties and from sources complying with Section 044200 "Exterior Stone Cladding."

2.2 STONE TYPES

A. Rip-rap (Angular Flag Rock)
1. Description: Durable rip-rap aggregate or angular cobble rock, with irregular, shape (to match landscape architect’s sample); size varies.
2. Sizes: 3-6” varying sizes.
3. Color: Colorado buff
4. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

B. Gravel Paving.
1. Crushed natural stone, 1/8-inch Gunnison gravel masonry sand, color – gray.

a. Basis of Design Supplier: The Rock Shop, Grand Junction, Colorado, 970-523-4216 or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 PREPARATION

A. Vacuum and/or Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

3.3 INSTALLATION, GENERAL

A. Do not use stone paving with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Set stone to comply with requirements indicated.

C. Tolerances:
1. Do not exceed 1/8-inch unit-to-unit offset from flush (lippage) or 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
2. Variation in Surface Plane: Do not exceed 1/8 inch in 10 feet from slope indicated.

3.4 AGGREGATE SETTING-BED APPLICATIONS (GRAVEL PAVING AND RIP RAP)

A. Prepare subgrade in accordance with requirements in Section 31 2000 “Earth Moving” and as indicated on Drawings.

B. Gravel Paving Preparation: Place on compacted setting bed.

C. Rip rap Preparation: Prepare in accordance with Architectural Drawings.
1. For conditions adjacent to architectural walls, place geotextile on compacted aggregate setting bed. Wrap ends and hold minimum 1/2-inch from finish surface. Secure geotextile to adjacent concrete surfaces.

D. Set stone paving as indicated on Drawings.

3.5 REPAIRING AND CLEANING

A. Remove and replace stone paving that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining stone paving. Provide new stone paving to match

adjoining stone paving and install in same manner as original stone paving, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess mortar, dirt or other debris from exposed stone paving surfaces; wash and scrub clean.

END OF SECTION 321440

SECTION 321723
PAVEMENT MARKINGS

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: Furnish and install all painted lines, accessibility symbols, or similar markings on paved surfaces, as shown on the drawings or specified herein, and as required to complete the work.

B. Related Work:

1. Division 32 Section “Asphalt Paving” for materials, installation and minimum requirements.

2. Division 32 Section “Concrete Paving” for materials, installation and minimum requirements.

1.3 REFERENCES

A. Reference Standards: Comply with the requirements of the reference standards noted herein, except where more stringent requirements are described herein or otherwise required by the Contract Documents.

B. Town of Carbondale Public Works Manual, 2009.

C. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

D. “Manual on Uniform Traffic Control Devices” latest edition.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s published descriptive literature and complete specifications for products specified herein.

1.5 QUALITY ASSURANCE

A. Qualifications: Pavement marking applicator shall be regularly engaged in this type of work, and shall provide adequate, experienced manpower and proper equipment to complete the work.

B. Regulatory Requirements: Comply with applicable provisions of Colorado State Department of Highways Specification Sections 627, 708, and 713.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Deliver materials in manufacturer's original, unopened containers, with labels intact and legible.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Do not apply pavement marking when ambient air and pavement surface temperature is below 40°F for paint and below 50°F for epoxy and thermoplastic marking materials, or when moisture in any form is present on the pavement surface.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Traffic Marking Paint: Acrylic Waterborne Paint or Low Volatile Organic Compound (VOC) solvent base paint, lead and chromate free, ready-mixed, cold-applied traffic marking paint complying with CDOT specification table 708-1, white or yellow color as designated on the plans for striping and lane markings, white and blue at international handicapped parking symbols. Acceptable products include Devoe Exterior "Safety Line" or approved equal.

A. Preformed Thermoplastic Pavement Marking: Markings shall consist of a resilient white or yellow thermoplastic product with glass beads uniformly distributed. Capable of being affixed to bituminous pavement by heating and applied to concrete per manufacture recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.2 PREPARATION

A. Surface Preparation: Allow fresh pavement surfaces to weather at least 30 days prior to application of traffic marking paint.

3.3 APPLICATION

A. Traffic Marking Paint: Unless otherwise indicated, apply traffic marking paint in nominal 4-inches wide stripes at the rate of 100 to 110 sf/gal.

B. Preformed Plastic Pavement Marking: Apply per manufacturers recommendations.

C. Patterns and Symbols:

1. Unless otherwise indicated, apply traffic markings in nominal 4-inches wide stripes with clear and sharp dimensions. See drawings for striping patterns and symbols.

2. Unless otherwise indicated, white markings at parking striping and white and blue markings at international handicapped symbols.

3. Comply with ANSI 117.1 and ADA requirements for graphic symbols, stall widths, and access aisles at handicapped parking spaces. Provide approved templates for symbols.

END OF SECTION 321723

This page intentionally left blank.

SECTION 323113
CHAIN LINK FENCES AND GATES

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. Chain-link fences.
2. Gates: horizontal slide

B. Related Sections:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7

1. Minimum Post Size and Maximum Spacing: Determine according to ASTM F 1043 for framework up to 6 feet high, and post spacing not to exceed 10 feet.

C. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

1. Fence and gate posts, rails, and fittings.
2. Gates and hardware.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified factory-authorized service representative.

B. Product Certificates: For each type of chain-link fence and gate, from manufacturer.

C. Product Test Reports: For framing strength according to ASTM F 1043.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
   1. Gate hardware.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.

   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

C. Preinstallation Conference: Conduct conference at Project site.

   1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
   2. Review coordination of interlocked equipment specified in this Section and elsewhere.
   3. Review required testing, inspecting, and certifying procedures.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire Fabric: Wire with a diameter of 0.192 inch

   a. Mesh Size: 2 inches

3. Selvage: Knuckled at both selvages

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:

1. Fence Height: 72 inches

2. Heavy Industrial Strength: Material Group IC, round steel pipe, electric-resistance-welded pipe.

   a. Line Post: 2.375 inches in diameter
   b. End, Corner and Pull Post: 2.875 inches in diameter

3. Brace Rails: Comply with ASTM F 1043.

2.3 HORIZONTAL-SLIDE GATES

A. General: Comply with ASTM F 1184 for gate posts and single sliding gate types.

1. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.

a. Gate Frame Width and Height: More than 48 inches wide by any height

B. Pipe and Tubing:
1. Aluminum: Comply with ASTM B 429/B 429M; manufacturer's standard finish.
2. Gate Posts: Comply with ASTM F 1184. Provide round tubular steel posts.
3. Gate Frames and Bracing: Round tubular steel

C. Frame Corner Construction: assembled with corner fittings.

D. Hardware:

1. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
2. Provide ADA operable gate.
3. Padlock and Chain: Provide ADA punch code lock similar to Model 2985 by Lockey. Include gate box and strike bracket.
4. Hangers, roller assemblies, and stops fabricated from galvanized steel.

2.4 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:

a. Hot-Dip Galvanized Steel: galvanized coating thickness matching coating thickness of chain-link fence fabric.

I. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc.

a. Polymer coating over metallic coating.

2.5 ANCHORING CEMENT

A. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Contracting Officer.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete by mechanically driving into soil at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
    b. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

3. Mechanically Driven Posts: Drive into soil to depth of 48 inches. Protect post top to prevent distortion.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more

D. Line Posts: Space line posts uniformly at 10 feet o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

G. Intermediate and Bottom Rails: Install and secure to posts with fittings.

H. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government’s personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

This page intentionally left blank.

SECTION 323310
EXTERIOR SIGNS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work shall consist of furnishing and installing accessible parking signs, site identification signs and hardware.

1.2 SUBMITTALS

A. Product samples of all signs.

B. Samples of all mounting hardware.

C. Shop Drawings: For panel signs.
   1. Include fabrication and installation details and attachments to other work.
   2. Indicate all materials used.
   3. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
   4. Show message list, typestyles, graphic elements, and layout for each sign to scale.

PART 2 - PRODUCTS

2.1 POSTS

A. Steel Posts: Steel posts shall meet the requirements of ASTM A 499, galvanized in accordance with AASHTO M 111. Minimum weight per foot will be as shown on the drawings.

   1. The posts shall have 7/16-inch holes drilled or punched, before galvanizing, along the centerline of the web. The punching or drilling should begin 1 inch from the top of the post, at 2-inch centers for the upper 5 feet of the post.

2.2 ACCESSIBLE SIGN PANELS

A. Aluminum Panels. MUTCD Regulatory Sign Numbers as indicated on Civil drawings.

Sign Width (Inches)	Sheet Aluminum Thickness (Inches)
Less than 8	0.022
8-12	0.040
13-19	0.063
20-30	0.080

2.3 SITE IDENTIFICATION SIGN "MONUMENT SIGN"

A. Sign:
   1. ¾" thick routed recycled HDPE Plastic brown-yellow and cream-brown color to match U.S. Forest Service standards and guidelines. Yellow-cream color for routed letters #23695 required.
   2. Digital graphic inlayed routed text to meet Forest Service Signs and Poster Handbook - MUTCD EM-7100-15 sign and letter sizes.
   3. Re-cycled plastic shall be Ultra-Violet radiation stabilized for durability and to inhibit color change over time. Signs shall not be painted.
   4. Wood Products Signs, Inc., 4890 County Road 76, Parlin, Colorado 81239. Phone: (1) 970-641-1675 or FAX: (1) 970-641-8107. Email: woodproductsigns@yahoo.com or catalog www.woodproductsigns.com or equal.

B. Shield:
   1. ¾" thick routed recycled HDPE Plastic. Colors to match U.S. Forest Service standards and guidelines.
   2. Digital graphic inlayed routed to meet Forest Service Signs and Poster Handbook - MUTCD EM-7100-15 sign and letter sizes.
   3. 12" Forest Service S-12 shield.
   4. Re-cycled plastic shall be Ultra-Violet radiation stabilized for durability and to inhibit color change over time. Shield shall not be painted.
   5. Wood Products Signs, Inc., 4890 County Road 76, Parlin, Colorado 81239. Phone: (1) 970-641-1675 or FAX: (1) 970-641-8107. Email: woodproductsigns@yahoo.com or catalog www.woodproductsigns.com or equal.

C. Plaque:
   1. ¾" thick routed recycled HDPE Plastic. Colors to match U.S. Forest Service standards and guidelines.
   2. Digital graphic inlayed routed to meet Forest Service Signs and Poster Handbook - MUTCD EM-7100-15 sign and letter sizes.
   3. P-52 USDA plaque.
   4. Re-cycled plastic shall be Ultra-Violet radiation stabilized for durability and to inhibit color change over time. Plaque shall not be painted.
   5. Wood Products Signs, Inc., 4890 County Road 76, Parlin, Colorado 81239. Phone: (1) 970-641-1675 or FAX: (1) 970-641-8107. Email: woodproductsigns@yahoo.com or catalog www.woodproductsigns.com or equal.

2.4 FITTINGS

A. Lag screws, washers, clip angles, wood screws, shear plates, U-bolts, clamps, bolts, nuts, and other fasteners shall be galvanized steel, cadmium-plated steel, aluminum alloy, or as shown on the drawings.

B. Galvanizing of steel hardware shall be in accordance with AASHTO M 232. High-strength steel bolts, nuts, and washers shall meet the requirements of ASTM A 325, except as shown on the drawings.

2.5 HARDWARE

A. ASTM A307, Grade A, zinc coated, size as shown on the drawings.

2.6 BUILDING ENTRANCE SIGN

A. Sign shall be design-build by sign fabrication company to meet the design intent as shown in the drawings.
   1. Lighting: Provide concealed LED strip light to internally illuminate lettering. Include a lens on the bottom of the sign so the same lamp provide illumination on the walking surface below.
   2. Sheet Steel Material: A 606-4 Weathering Steel, ASTM A 606-04 High Strength Low Alloy Weather Steel, or equal approved material to provide similar appearance.

PART 3 - EXECUTION

3.1 LOCATION

A. Sign location will be staked on the ground by the Government, prior to commencement of work. The longitudinal axis of the sign will be perpendicular to the centerline of the main road, plus or minus 5 degrees.

3.2 INSTALLATION

A. Base and sign supports shall be constructed plumb.

B. Mount signs with zinc coated hardware per drawings. Paint bolt heads, washers, nuts, and other hardware with Rust Inhibiting Flat Black Paint or an equal.

C. Mount signs, plaques, and shields in accordance with manufacturer’s instructions.

END OF SECTION 323310

This page intentionally left blank.

SECTION 329113
SOIL PREPARATION

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 planting soils and layered soil assemblies specified by composition of the mixes.

B. Related Requirements:
1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
2. Section 321440 "Stone Paving" for placing planting-soil fill in stone paving.
3. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
4. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of imported soil, soil amendment and fertilizer before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Samples: For each bulk-supplied material, 3 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Contractor will engage a qualified testing agency to perform preconstruction soil analyses on soils to remain or to be amended in place

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.8 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Landscape Architect or state-certified, -licensed, or -registered soil scientist under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations where directed by Contracting Officer for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: As directed by Contracting Officer.
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Contracting Officer for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.9 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard SSSA laboratory protocol including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil by addition of naturally derived organic materials.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Regional Materials: Imported soil and soil amendments and fertilizers shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

2.2 PLANTING SOILS SPECIFIED ACCORDING TO PERFOMANCE REQUIREMENTS

A. Planting-Soil Type 1: “Grasses”

Existing Amended Planting Soil from site and or Imported Planting Soil:

Existing, on-site surface soil, with the duff layer, if any, retained; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this

Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:

Imported, naturally formed soil from off-site sources and consisting of loam soil according to USDA textures; and modified to produce viable planting soil. Amend imported soil with materials specified in other articles of this Section to become planting soil complying with the following requirements:

1. Additional Properties of Imported Soil before Amending: minimum of 10 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration. Clean soil of the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
    c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 3 inches in any dimension.

2. Particle Size Distribution by USDA Textures: Classified as a sandy loam soil according to USDA textures.

3. Particle Size Distribution by Separates:

    a. Total Sand: 34 to 40 percent by dry weight.
    b. Silt: 35 to 40 percent by dry weight.
    c. Clay: 15 to 25 percent by dry weight.

4. Fragment Size Distribution:
    a. Sticks, debris and Other Foreign Materials: Maximum 1 percent by dry weight.

5. Percentage of Organic Matter: 9 to 18 percent by volume.
6. Soil Reaction: pH of 6.4 to 6.8
7. CEC of Total Soil: Minimum 10 meq/100 mL
8. Soluble-Salt Content: 5 to 10 dS/m measured by electrical conductivity.
9. Bulk Density: 1.1 g/cu. cm to 1.4 g/cu. cm at 85% compaction.
10. Total Porosity: Minimum 50 percent at 85% compaction.
11. Fertility: Per laboratory recommendation
12. Microbiological Content: per laboratory recommendation
13. RCRA Metals: Below maximum limits established by the EPA per section 31 23 23
14. Phytotoxicity: Below phytotoxicity limits established by SSSA

B. Planting-Soil Type 2: “Trees”

Existing Amended Planting Soil from site and or Imported Planting Soil:

Existing, on-site surface soil, with the duff layer, if any, retained; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:

Imported, naturally formed soil from off-site sources and consisting of loam soil according to USDA textures; and modified to produce viable planting soil. Amend imported soil with materials specified in other articles of this Section to become planting soil complying with the following requirements:

1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from agricultural land bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or noxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
2. Additional Properties of Imported Soil before Amending: Minimum of 10 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration. Clean soil to be of the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
    c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 3 inches in any dimension.

1. Particle Size Distribution by USDA Textures: Classified as sandy loam soil according to USDA textures.

2. Particle Size Distribution by Separates:

    a. Total Sand: 40 to 65 percent by dry weight.
    b. Very Coarse Sand: 6 to 7 percent by dry weight.
    c. Coarse Sand: 6 to 8 percent by dry weight.
    d. Medium Sand: 4 to 4 percent by dry weight.
    e. Fine Sand: 9 to 10 percent by dry weight.
    f. Very Fine Sand: 9 to 10 percent by dry weight.
    g. Silt: 5 to 35 percent by dry weight.
    h. Clay: 5 to 20 percent by dry weight.

3. Fragment Size Distribution:
    a. Sticks, debris and Other Foreign Materials: Maximum 1 percent by dry weight.

4. Percentage of Organic Matter: 9 to 18 percent by volume.
5. Soil Reaction: pH of 6 to 7
6. CEC of Total Soil: Minimum 10 meq/100 mL
7. Soluble-Salt Content: 5 to 10 dS/m measured by electrical conductivity.

8. Bulk Density: 1.1 g/cu. cm to 1.4 g/cu. cm at 85% compaction.
9. Total Porosity: Minimum 50 percent at 85% compaction.
10. Fertility: Per laboratory recommendation
11. Microbiological Content: per laboratory recommendation
12. RCRA Metals: Below maximum limits established by the EPA per section 31 23 23

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
3. Form: Provide lime in form of ground dolomitic limestone, or calcitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Compost: Well-composted, stable, and weed-free organic matter produced by composting leaf matter and feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
2. Reaction: pH of 5.5 to 8.
3. Soluble-Salt Concentration: Less than 4 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: 50 to 60 percent of dry weight.
6. Particle Size: Minimum of 98 percent passing through a 3/4-inch seive

B. Sphagnum Peat or Muck Peat shall not be used

C. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

1. Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. of loose sawdust or ground bark.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.5 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

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

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 3-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Government's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth indicated on Drawings but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments**,** except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

   a. Mix lime and sulfur with dry soil before mixing fertilizer.
   b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 6 inches or as indicated on Drawings. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Government's property.

C. Mixing: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.

1. Mix lime and sulfur with dry soil before mixing fertilizer.
2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to 82 percent of maximum Standard Proctor density according to ASTM D 698.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 2000 sq. ft. of in-place soil or part thereof.

C. Soil will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.7 PROTECTION

A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.8 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Government's property unless otherwise indicated.

END OF SECTION 329113

SECTION 329200
TURF AND GRASSES

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. Seeding.
2. Meadow grasses and wildflowers.

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Government for maintenance of turf and meadows during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: May 15.
2. Fall Planting: September 15.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED FESCUE

A. No Mow Lawn Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: No Mow Fescue (Festuca brevipila)

2.2 NATIVE RENOVATION GRASSES

A. Native Renovation Grass Seed Mix: Fresh, clean and dry new seed provided by Granite Seed Co., Lehi, UT (801) 768-4422 or equal.

1. Provide a seed mix composed of the following or approved equal:
   a. Western Wheatgrass *Pascopyrum smithii* 25%
   b. Slender Wheatgrass *Elymus trachycaulus* 25%
   c. Bluebunch Wheatgrass (“secar” variety) *Pseudoregneria spicata* 10%
   d. Green Needlegrass *Nassella viridula* 15%
   e. Blue Grama *Bouteloua gracilis* 15%
   f. Indian Ricegrass *Achnatherum hymenoides* 10%
2. Seed at a rate of 12 lbs per 1000 ft.
3. Install per Seed Supplier’s recommendations.

2.3 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Contracting Officer and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install 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.

3.3 SEED TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32-329113 "Soil Preparation."

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 NATIVE RENOVATION SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 12 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

E. Water newly planted areas and keep moist until meadow is established.

3.5 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.6 NATIVE RENOVATION GRASSES MAINTENANCE

A. Maintain and establish native renovation grasses by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and native renovation grasses damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep native renovation grasses and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water native renovation grasses with fine spray at a minimum rate of 1/2 inch per week for a minimum of four weeks after planting unless rainfall precipitation is adequate.

3.7 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.9 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 60 days from date of planting completion.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Native Renovation Grasses Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Meadow Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than maintenance period below.

1. Maintenance Period: 90 days from date of Substantial Completion.

END OF SECTION 329200

SECTION 329300
PLANTS

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. Plants.
2. Tree stabilization.
3. Tree-watering devices.

B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 329113 “Soil Preparation” for planting soil.
3. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag.

Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

H. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

I. Planting Area: Areas to be planted.

J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation for drawing designations for planting soils.

K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

N. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Organic Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
2. Weed Control Barrier: 12 by 12 inches.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Government for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Contracting Officer may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Contracting Officer may also observe trees and shrubs further for size

and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Contracting Officer of sources of planting materials 15 days in advance of delivery to site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.

3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: May 15.
2. Fall Planting: September 15.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Government.
b. Structural failures including plantings falling or blowing over.
c. Faulty performance of tree stabilization.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.

a. Trees, Shrubs, Vines, and Ornamental Grasses: 24 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Contracting Officer, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 5-gram, 10-gram, and 21-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Wood and bark chip.
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Natural.

2.4 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

2.5 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring 8 inches in diameter and 48 inches long, treated with specified wood pressure-preservative treatment
3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles or compression springs.
4. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cables: Five-strand, 3/16-inch-diameter, galvanized-steel cable, with zinc-coated turnbuckles or compression springs, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

2.7 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Contracting Officer and replace with new planting soil.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Contracting Officer’s acceptance of layout before excavating or planting. Make minor adjustments as required.

C. Lay out plants at locations directed by Contracting Officer. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Before planting, obtain Contracting Officer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected overnight after working hours.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Contracting Officer if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Contracting Officer if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Backfill: Use amended, excavated soil for backfill in accordance with Section 329113 "Soil Preparation."
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

    a. Quantity: Two for each caliper inch of plant.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Contracting Officer.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Contracting Officer, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated.

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle or compression spring for each guy wire and tighten securely.
b. For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle or compression spring for each guy wire and tighten securely.
c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.
d. Support trees with guy cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.
e. Attach flags to each guy wire, 30 inches above finish grade.
f. Paint turnbuckles or compression springs with luminescent white paint.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines 18 inches in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrub in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Government's operations and others in proximity to the Work. Notify Contracting Officer before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.11 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Contracting Officer.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

A. Remove trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that the Contracting Officer determines are incapable of restoring to normal growth pattern.

3.12 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Government's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

END OF SECTION 329300

This page intentionally left blank.

SECTION 331100
WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Additional information concerning water distribution systems may be found on the civil drawings. In case of conflict between the drawings and the information specified herein, the more stringent requirements shall govern.

C. Town of Carbondale Public Works Manual, 2009. Where conflicts arise between this Manual and the contract documents, the more stringent requirements are to be met.

1.2 SUMMARY

A. This Section includes water-distribution piping and specialties outside the building for the following:

1. Water services.

2. Public water mains.

3. Fire hydrants.

B. Work Included: Excavation, exploratory excavation (pothole), backfill, bedding, soil stabilization, ground water removal, connection to existing mains, and installation of pipe, thrust blocks, thrust restraints, valves, fittings, valve boxes, and all necessary appurtenances. Also includes removal and replacement of existing paving or concrete where required, haul and import of adequate backfill material to meet compaction requirements and removal of existing thrust blocks where necessary. Includes abandonment of valves and existing services as required.

C. Related work:

1. Division 31 Section "Site Clearing" for temporary utilities and support facilities may be included.

2. Division 31 Section “Earth Moving” for soil materials, site grading, site excavation and filling.

3. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.

4. Division 32 Section “Asphalt Paving” pavement patching over trenches.

5. Division 32 Section “Concrete Paving” for concrete structures, concrete materials and exterior concrete paving or walks.

6. Division 01 Section “Temporary Erosion and Sedimentation Control” for erosion and sedimentation control measures.

1.3 DEFINITIONS

A. Water Service: Exterior domestic-water service piping.

B. The following are industry abbreviations for pipe materials:

1. DIP: Ductile iron pipe.

2. CU: Copper pipe.

C. Trench Excavation: Excavation of all material encountered along trench other than rock excavation.

D. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 3/4 cu. yd. for footing, trench, and pit excavation which in the Geotechnical Engineer’s opinion cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.

E. All items under this section shall, at a minimum, conform to Town of Carbondale Public Works Manual.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Piping specialties.

2. Fittings.

3. Valves, valve boxes and accessories.

4. Fire hydrants.

5. Field Quality-Control Test Reports: From Contractor.

B. Test Reports: Submit two (2) copies of laboratory gradation tests for bedding and trench stabilization materials, concrete mix design, asphalt mix designs, and compression test.

C. Permits: Contractor to coordinate with the Government after award on obtaining permits for the project.

D. Certificates: Submit two (2) copies of acceptance from Health Department prior to placing water system in service.

E. Locates: Contractor must submit two (2) copies of utility locate drawings/receipts prior to beginning construction.

F. As-Builts: Provide the Contracting Officer with copies of redlined, as-built plans upon completion of construction. Horizontal and vertical information is to be certified by a Professional Land Surveyor. As-built information should include the following at a minimum:

1. All lengths, sizes, and materials of installed pipes.

2. Horizontal locations either by station and offset, or by northing and easting coordinates of all bends, valves, taps, plugs, tees, etc.

3. Top of pipe elevation at regular intervals and at fittings.

4. Any other variations from the construction documents must be clearly noted and detailed on the plans.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, material profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated.

B. Regulatory Requirements:

1. Comply with requirements of utility company supplying water, including tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, 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, including fire hydrants, 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 and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed 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.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Government or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify the Contracting Officer not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without the Contracting Officer’s written permission.

B. Environmental Requirements: Except by specific written authorization, cease concreting when descending air temperature in shade and away from artificial heat falls below 35 degrees F. and there is frost in subgrade. When concreting is permitted during cold weather, temperature of mix shall not be less than 60 degrees F. at time of placing.

C. Immediately pump or bail out water found in excavations, whether rain or seepage. Coordination and use of electric power is the Contractor's responsibility. Excavations must be kept free from water at all times.

D. It shall be the responsibility of the Contractor to take all measures and furnish all equipment and labor necessary to control the flow, drainage and accumulation of water as required to permit completion of the work under this section to avoid damage to all work at no additional cost to the Government.

E. It shall be the responsibility of the Contractor to take all measures and furnish all material, equipment and labor necessary to provide adequate backfill material as specified herein.

F. Water Service shall remain operational at all times until service change over is completed. Provide the Government with water as needed during outages and install temporary water service and meter to the Warehouse as indicated.

1.8 PROJECT RECORD DOCUMENTS

A. Maintenance of Documents: Store documents apart from drawings used for construction. File submitted documents in accordance with the specification's section numbers. Maintain documents in a clean, dry legible condition and in good order. Do not use record documents for construction purposes.

B. Recording: Label each document "PROJECT RECORD" in neat, large, printed letters. Record information concurrently with construction progress. Do not cover work until required information is recorded. Marking of project records shall be legible and with a dark pen or pencil. Ink shall not be water based due to easy

smearing. Mark drawings to record actual construction including field dimensions, elevations, details, changes made by a modification, details not on original drawings, horizontal and vertical locations of underground utilities and appurtenances referenced to a minimum of two permanent surface improvements, and depths of various elements of work in relation to project datum. All horizontal and vertical information is to be certified by a licensed Professional Land Surveyor.

C. Submission: Accompany submittal with transmittal letter in duplicate containing date, project title and number, Contractor's name, address and telephone number, title and number of each record document, and signature of Contractor or his authorized representative. Contractor shall submit two drawings and certified by a licensed Professional Land Surveyor depicting all as-built information to the The Contracting Officer.

1.9 PROTECTION

A. Barricades and Safety Provisions: Place and maintain until completion of work adequate barricades, construction signs, warning lights and guards to avoid property damage and protect persons from injury. Flares with open flames will not be permitted. Protect all materials, equipment, pipe and earth piles that may serve as hazards to vehicular or pedestrian traffic by barricades or guards and warning lights.

B. Shoring: Provide and maintain all sheeting, shoring and bracing required to safely retain earth banks. Protect adjoining grades and structures from caving, sliding, erosion or other damage, and suitable forms of protection against bodily injury; all in accordance with applicable codes and governing authorities.

Do not remove any sheeting unless the pipe strength is sufficient to support the trench loads based on trench width measured to the back of sheeting. Remove sheeting and shoring gradually as excavation backfilling progresses to protect the construction or other structures, utilities or property. Do not attempt removal of sheeting in one operation after backfilling is complete.

C. All work must comply with latest OSHA requirements.

D. Utilities: Protect from damage existing utility lines shown on drawings or locations of which are made known to contractor prior to work and utility lines constructed during construction operations of the project. Hand excavate within six inches of known piping or objects to prevent damage from equipment. Before commencing work, obtain information concerning location, type, and extent of concealed existing utilities on the site and adjacent properties. Repair damage to utilities at no cost to the Government.

E. Granular Fill: Protect existing granular fill adjacent to existing structures from dirt that would impede free drainage. Remove and replace any portions of granular fill that become contaminated with dirt.

F. Drainage: Maintain the excavations and site free from water throughout the work. Remove any water encountered in the trench to provide firm subgrade, to permit joints to be made dry at the final grade, and to prevent entrance of water into the pipeline. Accomplish the foregoing by the use of sumps and gravel blankets, well points, or drainlines. Contractor shall obtain all permits associated with dewatering.

Rock, gravel, and other appurtenances used to keep trenches free from water or used to add support to installed piping is considered incidental to construction and all costs shall be the responsibility of the Contractor.

G. Survey Control Monuments and Range Boxes: Protect existing survey control monuments from damage. Contractor will be responsible for replacement or repair of any monument damaged or destroyed. Replacement of monuments must be performed by a qualified land surveyor.

1.10 COORDINATION

A. Coordinate connection to water main with the Contracting Officer and the Town of Carbondale.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Ductile-Iron Pipe And Fittings

1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, thickness Class 52 with cement-mortar lining, AWWA C104 with mechanical-joint, bell- and plain-spigot end.

a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C153, ductile-iron compact pattern, pressure rating 350 psi.

b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and high-strength, low alloy steel bolts such as Cor-Ten.

c. All fittings cement – mortar lined, AWWA C104.

d. Bituminous outside coating one mil thick for underground services.

2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, thickness Class 52 with cement mortar lining, AWWA C104 with push-on-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.

a. Push-on-Joint, Ductile-Iron Fittings: AWWA C153, ductile-iron compact pattern.

b. Gaskets: AWWA C111, rubber.

c. Cement mortar lined, AWWA C104.

d. Bituminous outside coating one mil thick for underground services.

B. Copper Tube And Fittings

1. Soft Copper Tube: ASTM B 88, Type K buried, water tube, annealed temper.

a. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

2. Hard Copper Tube: ASTM B 88, Type K water tube, drawn temper.

a. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 PIPING SPECIALTIES

A. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.

1. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.

B. Mechanical Joint Restraint

1. General: All mechanical joint restraints shall be incorporated in the design of a follower gland. The gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA C111 and C153.

2. Description: The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. The gripping surfaces shall be wedges designed to spread the bearing surfaces on the pipe. Twist-off nuts, sized same as tee-head bolts, shall be used to insure proper

actuating of restraining devices. When the nut is sheared off, a standard hex nut shall remain.

3. Pressure: The mechanical joint restraint device for ductile iron pipe shall have a working pressure of at least 350 psi with a minimum safety factor of 2.

4. Acceptable Manufacturer: The mechanical joint restraint devices shall be of the type listed below or equal, and approved by Town of Carbondale prior to bidding:

For Ductile Iron Pipe:

EBAA Iron, Inc. Megalug 1100 series (4-inches – 36-inches)

Uni-Flange Series 1400 (4-inches – 36-inches)

2.3 CORROSION-PROTECTION ENCASEMENT FOR PIPING

Encasement for Underground DIP and CIP Piping: AWWA C105, PE film, Type I, Class A, Grade E-1 (ASTM D1248), 1200 lbs per square inch minimum tensile strength, 300% elongation, 800 v/mil thickness minimum dielectric strength, minimum thickness, tube or sheet.

2.4 GATE VALVES AND ISOLATION VALVES

1. AWWA, Cast-Iron Gate Valves:

2. Manufacturers:

   a. Mueller

3. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut. Valve stem shall have a minimum yield strength of 40,000 psi, minimum elongation of 2-inches of 12%, and shall be per ASTM A276, type 304 or 316; or AISI 420. Wrench nuts in accordance with 4.11 of AWWA C509. Stem seal shall consist of two (2) O-rings in accordance with Section 4.8 of AWWA C509. The valves shall open by turning to the left.

   a. Minimum Working Pressure: 200 psig.

   b. End Connections:

      1) Flanges: Flanges shall be sized and drilled in accordance with ANSI B16.1 Class 125. Flanges shall be machined to a flat surface with a serrated finish in accordance with AWWA C207.
      2) Mechanical Joint: All components of this type of joint shall conform to AWWA C111. The tee-head bolts and hexagon nuts

shall be fabricated from a high-strength, low alloy steel known in the industry as Cor-Ten Usalloy, ductile iron Durabolt or equal.

c. Interior Coating: Complying with AWWA C550.

d. Bolting Material: Bonnet and gland bolts and nuts shall be either fabricated from a low alloy-steel for corrosion resistance or electro-plated with zinc or cadmium. The hot-dip process in accordance with ASTM A153 is not acceptable.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include extension of length required for depth of burial of valve, plug with lettering "WATER,". Valve boxes shall be the three-piece adjustable screw type. The top section shall be 16-inches long. The following pattern is acceptable.

Tyler screw-type 6-inch cast iron valve box assembly series 6860 with No. 160 oval base.

D & L Supply Series M-9000 with No. 160 oval base Sigma Model No. VB630.

Star Pipe Model No. VBD160DMWW

Western States Pipe Model No. VBDEN

Olympic Foundry Inc. Model No. 450VB

Castings Inc. CI. 160B Oval Base

2.6 CORPORATION VALVES AND CURB VALVES

A. Manufacturers:

	Corp Stop	Curb Stop
1.	Mueller	300-B25029 B25204

2. Manufacture pre-approved by agency having jurisdiction.

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine. Double bronze strapped for use with DIP and PVC and cement asbestos pipe and meet requirements of jurisdiction.

1. Service Saddle: Stainless steel with seal and AWWA C800, threaded outlet for corporation valve.

a. Manufacturer: Mueller H 16,000 Series.

2. Corporation Valve: Broass or bronze body and ground-key plug, with AWWA C800, threaded CC type inlet and compression fittings outlet matching service piping material.

3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800. Include bronze body, Teflonball valve type, and standard tee head operator, with compression fittings for inlet and outlet matching service piping material (copper to copper).

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over curb valve, and approximately 3-inch diameter barrel. Manufacturer Mueller H-10314 or equal for 0.75 inch to 1 inch curb box.

2.7 FREESTANDING FIRE HYDRANTS

Comply with all local jurisdictions requirements and provide at a minimum the following:

A. Dry-Barrel Fire Hydrants: AWWA C502, one 4-1/2 inch NST and two 2-1/2 inch NST outlets located at least 18-inches above ground, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Complete with plain rubber gasket, gland, bolts and nuts per AWWA C111. Bolts and nuts to be high strength low alloy corrosion resistant steel Cor-Ten minimum yield 50,000 lbs per square inch ASTM A242. Include two (2) lugs into bore for rodding of pipe. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure, and 250-psig minimum working-pressure design.

B. Main Valve Assembly: Main valve of the hydrant shall be the compression type which closes with the water pressure. Seat ring shall be bronze with a machined face and external threads for threading into a bronze drain ring, or a bronze bushed shoe to provide bronze to bronze seating for the main valve. The assembly shall be sealed with O-rings.

Main valve shall be replaceable type fabricated of a resilient material with a threaded bottom plate or nut with a seal to prevent leakage of the hydrant shaft. The upper valve plate material shall be either bronze or epoxy coated ductile iron.

The valve assembly shall include one or more drain valves which will work automatically with the main valve and drain the barrel when the main valve is in the closed position. All drain tubes shall be bronze lined and sized large enough for the barrel to drain within 12 minutes when the barrel is sized for a 5-foot trench depth.

All parts of the main valve assembly shall be so designed that removal of the assembly from the barrel is accomplished without excavation in accordance with AWWA C502 3.4.1.

C. Operating Shaft and Nut: The bronze operating nut shall be bronze or ductile iron and shall be pentagon shaped with a finished height of 1 1/8-inch. The dimensions from point-to-flat shall be between 1 ¼-inch and 1 3/8-inch from the top and to the bottom of the nut. Bushings in bonnet shall be so constructed that it will prevent the operating nut from traveling during opening or closing operation. Also the bushing shall house a gasket or seal to prevent moisture or foreign material from entering the lubricant reservoir.

All hydrants shall be grease lubricated or shall be the dry-top design where an oil reservoir provides permanent lubrication of the operating nut threads.

A stop nut located in the hydrant bonnet on the operating shaft shall prevent over travel of the main valve when being opened.

The hydrant shall open by turning the operating nut to the left in a counter-clockwise direction and shall have an arrow on top of the bonnet to designate the direction of opening.

D. Pumper Nozzle and Cap: The pumper nozzle shall be 4 ½-inches nominal diameter with 5 3/8-inches outer diameter threads having 6 threads per inch. Threads shall be right-hand.

Nozzle cap shall be furnished with a synthetic rubber gasket installed in a retaining groove and the dimensions and shape of the nozzle cap nut shall be the same as the operating shaft nut as described above.

Nozzle caps shall be furnished with security chains with one end of each securely attached to the upper barrel section of the hydrant.

E. Hose Nozzles and Caps: The two hose nozzles shall be 2 ½-inches nominal diameter with 7 1/2 threads per inch (2.5 – 7.5 N.H.). Threads shall be right-hand and National Standard in accordance with NFPA No. 194. Each hose nozzle shall include a nozzle cap with nut and security chain the same as described above.

F. Nozzle Attachment: Outlet nozzles shall be fastened into the barrel by mechanical means and secured by a stainless steel pin or screw, bronze wedge or a ductile iron retainer. Nozzles shall be sealed by the use of O-rings.

G. Color: The upper exposed section of the hydrant above ground shall be thoroughly cleaned and then painted with a prime coat of a rust inhibitive primer followed by a 10-mil thick shop coat of heavy duty alkyd enamel paint. The paint color shall be red.

All exposed exterior surfaces below the ground line shall be coated with asphalt varnish or equal in accordance with 4.2.3 of AWWA C502.

The interior of the hydrants shall be coated with an epoxy coating in accordance with 4.2.4 of AWWA C502. The epoxy paint shall be NSF 61 approved.

H. Traffic Features: All hydrants shall be equipped with traffic features that include a break away flange or lug system with a shaft coupling.

I. Acceptable Brands:

Manufacturer	Model No.
Mueller	Centurion A423

Manufacturer pre-approved by agency having jurisdiction

J. MUELLER: Conforming to AWWA Standard C502. Working pressure 250 psi. Depth and cover as shown on drawings for location of hydrant. 6-inches mechanical joint inlet, minimum 5-1/4-inches compression-type main valve which closes with pressure, two 2-1/2-inches hose nozzles with 7-1/2-inches threads per inch, and streamer shall have 4 threads per inch National Standard, or a specified by Southwest Adams County Fire Protection District. Nozzle threads ANSI B26. Nozzles easily replaced in field with standard tools. Operating and cap nuts 1-1/2-inches No. 17 National Standard hex main valve opening left (counter-clockwise). Direction of opening indicated by arrow cast on top of hydrant. Breakable section which permits clean break at or near ground level, preventing water loss in case of breakage. Working parts removable for maintenance or repair without excavation. Operating mechanism non-wetting, oil reservoir lubricated, with O-ring seals. Barrel drain bronze mounted with at least two outlets, and operate automatically with main valve.

2.8 MORTAR

Masonry mortar shall be Type S conforming to ASTM C270.

The mortar shall consist of one part cement, 0.15 part lime, and three parts sand, measured by volume. The cement, lime and sand shall be first mixed dry to a uniform color in a suitable box or batch mixer and then mixed with water thoroughly; the water being added gradually until the required consistency is obtained. Mortar shall be mixed in batches of such size as will be used immediately. Retempered mortar, or any mortar which has been mixed for more than one-half hour shall not be used. When mortar is molded into briquettes one square inch in cross-section, it shall attain an ultimate tensile stress of 125 pounds per square inch after one day in air and six days in water, and 175 pounds per square inch after one day in air and twenty-seven days in water.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Refer to Division 31 Section "Trenching and Backfilling" for excavating, trenching, and backfilling.

B. Exploratory Excavation: It shall be the Contractor's responsibility to excavate and locate all existing utilities which may affect construction of the water facilities. All exploratory excavations shall occur far enough in advance to permit any necessary relocation to be made with minimum delay and to verify existing vertical and horizontal location to determine alignment for the proposed water line. All costs incurred by the Contractor in making exploratory excavations shall be considered to be included in the unit price bid for constructing each section of water line or the associate structures.

C. Unstable Trench Bottom

Where trench does not have sufficient strength to support pipe and bedding, or stream crossings are encountered, use one of following methods to repair trench bottom as approved by the Contracting Officer. A minimum depth of repair is 2-feet.

1. Embankment: Clear and strip existing surface of all unacceptable material. Place embankment material agreed to by the Contracting Officer, compact to 95% AASHTO T99.

2. Aggregate Trench Bottom, percent by weight passing square mesh sieves: 1-½", 90-100; 3/4", 50-90; No. 4, 30-50; No. 200, 3-12.

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, unions, or keyed couplings for underground piping.

D. Flanges, unions, keyed couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

3.3 JOINT CONSTRUCTION

A. Make pipe joints according to the following:

1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

2. Copper Tubing Soldered Joints: ASTM B 828. Use flushable flux and lead-free solder.

3. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

B. Pipe Jointing:

1. General: Cut pipe for inserting valves, fittings, or closure pieces in neat and workmanlike manner with no damage to pipe or lining. Leave smooth end at right angles to axis of pipe.

2. Mechanical Joints: Thoroughly clean last 8-inches of spigot and inside bell to remove oil, grit, tar, and other foreign matter. Coat spigot and gasket with solution furnished by pipe manufacturer. Slip cast-iron gland on spigot end of pipe with lip extension of gland toward spigot end. Coat gasket with joint lubricant and place on spigot end of pipe to be laid, with thick edge toward gland.

Push entire section forward to seat spigot in bell of pipe in place. Press gasket into place within bell, even around entire joint. Move ductile-iron gland along pipe into position for bolting all nuts with suitable torque wrench. Alternately tighten nuts 180 degrees apart to produce equal pressure on all parts of gland.

Pipe Size	Bolt Size	Range of Torque
Inches	Inches	Ft.-Lb.
4"-24"	3/4	75 - 90

3. Push-on Joints: Thoroughly clean exterior 4-inches of pipe spigot and inside of adjoining bell to remove all oil, grit, tar, and other matter. Place gasket in bell with large round side of gasket pointing inside pipe bell. Apply thin film joint lubricant over gasket's entire exposed surface. Wipe spigot end of pipe clean and insert into bell to contact gasket. Force pipe into bell to manufacturer's jointing mark.

4. Flanged Joints: Thoroughly clean faces of flanges of all oil, grease, and other material. Thoroughly clean rubber gaskets and check for proper fit. Assure proper seating of flanged gasket. Tighten bolts so pressure on gasket is uniform. Use torque wrenches to insure uniform bearing. If joints leak when hydrostatic test applied, remove and replace gaskets and retighten bolts.

C. Thrust Restraint: Install in accordance with Town of Carbondale Standards and construction drawings. Removal of existing thrust blocks and rodding is the sole responsibility of the Contractor. Any damage caused by the removal of thrust blocks, regardless of size, or rodding shall be paid for by Contractor.

3.4 PIPING INSTALLATION

A. General: Deliver, handle, store, and install in accordance with the pipe manufacturer's recommendations and the applicable paragraphs of AWWA C600, AWWA C603, and ASTM D2321.

Carefully examine all pipe and fittings for cracks and other defects. Groove in bells of ductile iron pipe to be full and continuous or be rejected. Remove all foreign matter from interior and ends of pipe and appurtenances before lowering into trench. Carefully lower all pipe, fittings, valves, and hydrants into trench piece by piece to prevent damage to pipe materials, protective coatings, and linings. Do not dump into trench. If pipe cannot be lowered into trench and into place without getting earth into it, place heavy, tightly woven canvas bag over each end and leave in place until joints are made. During pipe laying, place no debris, tools, clothing or other materials in pipe.

Keep trenches free from water during pipe laying and jointing. Dewatering of trench considered as incidental to construction and all costs included in contract prices. When pipe laying is not in progress, close open ends of pipe by watertight plug, or other means approved by the Contracting Officer.

Dewatering shall be accomplished by the use of well points, sump pumps, rock or gravel drains placed below subgrade foundations or subsurface pipe drains. All water shall be disposed of in a suitable manner without being a menace to public health or causing public inconvenience. No water shall be drained into other work being completed or under construction. Obtain all necessary permits for dewatering.

The dewatering operation shall continue until such time as it is safe to allow the water table to rise in the excavations. Pipe trenches shall contain enough backfill to prevent pipe floatation.

Water shall not be allowed to rise until the concrete has set a minimum of twenty-four (24) hours, and the forms have been removed. Water shall not be allowed to rise unequally against unsupported structural walls.

B. Deflection of Pipe: Do not exceed deflection limits for each type of pipe as recommended by pipe manufacturer.

C. Water-Main Connection: Cut tee into water main according to requirements of Town of Carbondale and of size and in location indicated.

D. Make connections 2-inches and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.

2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.

3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.

4. Install corporation valves into service-saddle assemblies.

5. Install curb valve in water-service piping with head pointing up and with service box.

E. Install ductile iron pipe and fittings according to AWWA C600.

F. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

G. Bury piping with depth of cover over top at least 72-inches (6 feet).

H. 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.

I. 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.

3.5 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, Water-Service Piping: According to AWWA C600.

B. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVES AND HYDRANTS

A. Carefully inspect valve and hydrant before installation. Clean interior. Operate valve and hydrant to determine parts in proper working order, with valves seating and drain valve operating properly. Set plumb and securely brace into place. Set hydrant with bury line at finish grade, with hose nozzles parallel to and pumper nozzle facing pavement, at least 6-inches behind curb or sidewalk and 18-inches from property line or as shown on drawings. Provide drainage pit having 9 square feet of surface area and 2' of depth below seep hole. Backfill pits with 1-1/2-inches washed rock to 6-inches above barrel drain hole. Provide thrust blocking at bowl of each hydrant as shown on drawings. Do not obstruct barrel drain hole. Hydrants and valves backfilled by installing 1-1/2-inches aggregate road base to subgrade. Valve boxes centered and plumb over the operating nut. Valve boxes supported by bricks or other means to prevent any shock or stress transmitted to pipe or valve. Set valve box covers to just below subgrade level to prevent damage during construction of surfacing if applicable. Adjust to grade of surfacing.

B. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

C. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.7 SANITARY SEWER CROSSING

A. Normal conditions: Whenever possible lay water mains over sanitary sewers to provide vertical separation of at least 18-inches between invert of water main and crown of sewer.

B. Unusual Conditions: If above separation cannot be met, use following:

1. Sewer passing over or less than 18” under water main:

   a. Install one piece of C900 PVC pipe centered over the waterline with a solid sleeve coupler with transition gaskets.

   b. Install a grout collar over the two sewer joints on either side of the water crossing. The grout collar shall be around the entire perimeter of the joint and shall have 3-4 rebars around the circumference of the pipe.

   c. If clearance is less than 12 inches vertically, the space between the water and sewer mains shall be filled by 3,000 psi concrete.

2. Water mains passing under sewers: If vertical separation less than 18-inches, provide structural support for sewer.

3. In all cases, bedding material shall be used to prevent any settling of the higher pipe.

4. Sewer pipe encased in 6-inches concrete around pipe, and extend 10' either side of water main.

3.8 UTILITIES ENCOUNTERED

Protection of all existing gas, water, sewer services, drains, cable, telephone lines and electric lines encountered during construction is the Contractor's responsibility. If utilities are disturbed, they shall be maintained and/or restored to original condition at the Contractor's expense. Backfill around utilities shall be adequately compacted to assure permanent stability.

3.9 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. Notify the Contracting Officer at least 24 hours in advance of pipe being laid in any trench. Cover no pipes until observed by the Contracting Officer. Notify the Contracting Officer at least 48 hours before pipe is to be tested. All water mains are to be disinfected, flushed, and hydrostatically tested per Town of Carbondale Regulations.

C. Hydrostatic Testing:

1. General: Make pressure and leakage tests on all newly laid pipe and service lines. Test shall be conducted between valved sections of the pipeline. Water service lines will be tested up to the closed curb stop. Test first section of pipe laid to verify if watertight. Lay no additional pipe until first test section has passed tests.

2. Furnish following equipment and materials for tests, unless otherwise directed by the Contracting Officer:

Amount	Description
2	Approved graduated containers
2	Pressure gauges
1	Hydraulic force pump approved by Town
1	Additional 0.75 inch pressure tap for Town’s gauge
1	Suitable hose and suction pipe as required

3. Testing Procedure: Do not conduct pressure tests until 5 days after placement of concrete thrust blocks. If High-Early cement is used for the concrete thrust blocks, the time may be cut to 2 days. Conduct the pressure test in the following manner unless otherwise approved: After pipe has been partially backfilled with joints left exposed, fill the pipe with water, expelling all air during the filling. The test pressure shall be 1.5 times normal static system working pressure of the pipe at the point of lowest elevation (test minimum 150 psi).

   a. Duration

      1) The duration of each pressure test shall be two hours, unless otherwise directed by the Town.

   b. Procedure

      1) Slowly fill the pipe with water and allow to stand for 24 hours. Expel all air from the pipe. Apply and maintain the specified test pressure by continuous pumping in necessary pressure for the entire test period. The test pressure shall be calculated for the point of lowest elevation, or as specified by the Town. The pump suction shall be in a barrel or similar device, or metered so the amount of water required to maintain the test pressure may be measured accurately.

      2) Before the line is pressurized, the Town shall verify that all the necessary main line valves are open or closed with regard to the section of line being tested. In addition, the Town shall verify that all hydrant valves are open

   c. Leakage

      1) Leakage shall be defined as the quantity of water necessary to hold the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{ND\sqrt{P}}{7400}$$

In the above formula:

L = Allowable leakage (in gallons per hour)
N = Number of joints in the length of pipe tested
D = Nominal diameter of pipe (in inches)
P = Average test pressure during the leakage test (in pounds per square inch gauge).

d. Correction of Excessive Leakage

1) Should any test of pipe laid disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

e. Flow Test

1) After new line has been leak tested, the line shall be flushed by opening 1 or more fire hydrants for approximately 10 minutes or until sediment has been

flushed from system.

D. Prepare reports of testing activities.

3.10 FLUSHING AND DISINFECTING

A. Services greater than 1.5" shall be disinfected as main lines.

B. General: In accordance with AWWA C600 and C651 *Standard for Disinfecting Water Mains*. The chlorinating agent and method of application shall be in accordance with AWWA C651. The contractor shall provide material for disinfecting of water mains.

C. If the tablet method of chlorination is used, during construction, calcium hypochlorite granules shall be adhered, with a NSF 61 approved adhesive, to the inside top of every stick of pipe. The quantity of granules shall be as shown in the table below. This method may be used only if the pipes and appurtenances have been kept cleaned and dry during construction. This method is not to be used on solvent welded plastic or on screwed joint steel pipe because of the danger of fire or explosion from the reaction of the joint compound with the calcium hypochlorite.

65% Calcium Hypochlorite Granules
To be placed at the beginning of the new line

Pipe Diameter	**Ounces**
4" and smaller	0.5
6"	1.0
8"	2.0

After the pipe is filled with water and chlorine, and unless approved otherwise by the Town, the chlorinated water shall be held in contact with the pipe for 24 hours; under cold water conditions contract time should be 48 hours. At the end of the 24-hour period, the water in the pipeline shall be tested by the Town to ensure residual chlorine content of not less than

25 mg/l. The pipeline shall then be thoroughly flushed to remove the heavily chlorinated water and/or debris. Care shall be taken in flushing the pipeline to prevent property damage and danger to the public. Discharge of highly chlorinated water shall not be released to any stream or watercourse. Samples of water will be collected for bacteriological examination and residual chlorine content testing before the pipeline is put into service. The Town will not perform testing of residual chlorine and bacteriological sampling and testing. All bacteriological testing shall conform to AWWA Standards required by one test immediately and another test 24 hours later.

D. If the continuous feed method of chlorination is used, the Contractor is to provide the written procedure to the Town Inspector for acceptance of the method at least 48 hours prior to starting the work.

E. No main that has been disinfected and flushed shall stand stagnant for more than 15 days without being reflushed and a new disinfecting test performed, passed and approved by the Town.

F. Contractor and Developer shall not discharge chlorinated water to any water body, or the Town's sewer system until the chlorine is neutralized and eliminated.

3.11 IDENTIFICATION

A. Install continuous underground warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. See Division 31 Section "Trenching and Backfilling" for underground warning tapes.

3.12 OPERATION OF VALVES

Contractor is responsible for operating any valves necessary to complete project. Contractor is required to provide the Government 24 hours notice prior to said operation.

3.13 CLEANUP AND RESTORATION

Restore all pavements, curbs, gutters, utilities, fences, irrigation ditches, yards, lawns, and other structures or surfaces to condition equal to or better than before work began, and to satisfaction of The Contracting Officer. Deposit all waste material in designated waste areas. Grade and shape disposal site. Complete topsoil and reseeding of site, if required. Where disposal sites are not designated, remove and dispose of all waste material off site.

END OF SECTION 331100

SECTION 333100
SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Included: connection to existing manholes and installation service wyes, cleanouts, service lines, testing, and all necessary appurtenances and safety precautions.

B. Related Sections:

1. Division 31 Section "Site Clearing" for temporary utilities and support facilities may be included.

2. Division 31 Section “Earth Moving” for soil materials, site grading, site excavation and filling.

3. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.

4. Division 32 Section “Asphalt Paving” pavement patching over trenches.

5. Division 32 Section “Concrete Paving” for concrete structures, concrete materials and exterior concrete paving or walks.

6. Division 01 Section “Temporary Erosion and Sedimentation Control” for erosion and sedimentation control measures.

C. All items under this section shall, at a minimum, conform to Town of Carbondale Public Works Manual, 2009.

1.3 DEFINITIONS

A. PE: Polyethylene plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Submit shop drawings or product data showing specific dimensions and construction materials for pipe, fittings, and manholes or certifications that products conform with specifications.

B. Test Reports: Submit all field quality control test reports.

C. Permits: Contractor to coordinate with the Government after award on obtaining permits for the project.

D. As-Builts: Provide The Contracting Officer with copies of redlined, as-built plans upon completion of construction. Horizontal and vertical information is to be certified by a Professional Land Surveyor. As-built information should include the following at a minimum:

1. All lengths, sizes, slopes, and materials of installed pipes.

2. Horizontal locations either by station and offset, or by northing and easting coordinates of all bends, cleanouts, wyes, etc.

3. Invert elevations of sanitary sewer at manholes, bends, cleanouts, top of pipe elevations of each utility crossing, etc.

4. Constructed slope of sanitary pipes between manholes and structures.

5. Any other variations from the construction documents must be clearly noted and detailed on the plans.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. PROJECT CONDITIONS

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

1. Notify the Contracting Officer no fewer than 2 days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without the Contracting Officer's written permission.

E. Environmental Requirements: Except by specific written authorization, cease concreting when descending air temperature in shade and away from artificial heat falls below 35 degrees F., and there is frost in subgrade. When concreting is permitted during cold weather, temperature of mix shall not be less than 60 degrees F at time of placing.

F. Immediately pump or bail out water found in excavations, whether rain or seepage. Coordination and use of electric power is the Contractor's responsibility. Excavations must be kept free from water at all times.

G. It shall be the responsibility of the Contractor to take all measures and furnish all equipment and labor necessary to control the flow, drainage and accumulation of water as required to permit completion of the work under this section to avoid damage to all work at no additional cost to the Government. Contractor is responsible for discharge permit as required by local or State jurisdiction.

1.6 PROJECT RECORD DOCUMENTS

A. Maintenance of Documents: Store documents apart from drawings used for construction. File submitted documents in accordance with the specifications' section numbers. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.

B. Recording: Label each document "PROJECT RECORD" in neat, large, printed letters. Record information concurrently with construction progress. Do not cover work until required information is recorded. Marking of project records shall be legible and with a dark pen or pencil. Ink shall not be water based due to easy smearing. Mark drawings to record actual construction including field dimensions, elevations, details, changes made by a modification, details not on original drawings, horizontal and vertical locations of underground utilities and appurtenances referenced to a minimum of two permanent surface improvements, and depths of various elements of work in relation to project datum.

C. Submission: Accompany submittal with transmittal letter in duplicate containing date, project title and number, Contractor's name, address and telephone number, title and number of each record document, and signature of Contractor or his authorized representative. Contractor shall submit two drawings and certification of data by a Professional Land Surveyor depicting all as-built information to the Contracting Officer.

1.7 PROTECTION

A. Barricades and Safety Provisions: Place and maintain until completion of work adequate barricades, construction signs, warning lights and guards to avoid property damage and to protect persons from injury. Flares with open flames will not be

permitted. Protect all materials, equipment, pipe, and earth piles that may serve as hazards to vehicular or pedestrian traffic by barricades or guards and warning lights.

B. Utilities: Protect from damage existing utility lines shown on drawings or locations of which are made known to contractor prior to work, and utility lines constructed during construction operations of the project. Hand excavate within 6-inches of known piping or objects to prevent damage from equipment. Before commencing work, obtain information concerning location, type, and extent of concealed existing utilities on the site and adjacent properties. Repair damage to utilities at no cost to the Government.

C. Drainage: Maintain the excavations and site free from water throughout the work. Remove any water encountered in the trench to provide firm subgrade, to permit joints to be made dry at the final grade, and to prevent entrance of water into the pipeline.

Rock, gravel, and other appurtenances used to keep trenches free from water or used to add support to installed piping is considered incidental to construction and all costs shall be the responsibility of the Contractor.

D. Survey Control Range Boxes: Protect existing survey control monuments from damage. Contractor will be responsible for replacement or repair of any monument damaged or destroyed. Replacement of monuments must be performed by a qualified land surveyor.

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

A. PVC Sewer Pipe and Fittings, 15-inches and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals. Maximum pipe length 20-feet.

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 Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

2.4 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Manufacturers:

a. Josam Company.

b. MIFAB Manufacturing Inc.

c. Smith, Jay R. Mfg. Co.

d. Wade Div.; Tyler Pipe.

e. Watts Industries, Inc.

f. Watts Industries, Inc.; Enpoco, Inc. Div.

g. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Top-Loading Classification: Extra-heavy duty.

3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

1. Manufacturers:

a. Canplas Inc.

b. IPS Corporation.

c. NDS Inc.

d. Plastic Oddities, Inc.

e. Sioux Chief Manufacturing Company, Inc.

f. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.

2.5 CONCRETE

A. General: Contractor is responsible for replacement of curb, gutter, sidewalks and cross pans. Removal and replacement of the above items will be included under piping bid item. All workmanship and products furnished shall be per Division 32, section “Concrete Paving.”

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. Portland Cement Design Mix: 4000 psi at 28 days minimum, with 0.45 maximum water/cementitious materials ratio.

1. Proportions:

Cement 5-1/2 sacks per cubic yard.
Coarse aggregate – 43%.
Water – 5.5 gallons per sack.
Maximum size aggregate – ¾-inch.

2. Slump: 4” maximum.

3. Air Content: 5% - 7%.

4. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

5. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.48 maximum water/cementitious materials ratio.

6. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.

7. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

D. Job Mixed Concrete will not be allowed.

E. Ready Mixed Concrete: Proportioned, mixed, and transported in accordance with ASTM C94. Any concrete not plastic and workable when it reaches project shall be rejected.

F. Expansion Joint Material: AASHTO M173.

G. Curing Materials:

1. Burlap Cloth from Jute or Kenaf: AASHTO M182.

2. White Liquid Membrane: AASHTO M148, 1 gal/150 SF.

3. Sheet Materials: AASHTO M171, 4 mil.

2.6 MORTAR

A. The mortar shall consist of one part cement, 0.15 part lime, and three parts sand, measured by volume. The cement, lime and sand shall be first mixed dry to a uniform color in a suitable box or batch mixer and then mixed with water thoroughly; the water being added gradually until the required consistency is obtained. Mortar shall be mixed in batches of such size as will be used immediately. Retempered mortar, or any mortar which has been mixed for more that one-half hour shall not be used. When mortar is molded into briquettes one square-inch in cross-section, it shall attain an ultimate tensile stress of 125 pounds per square-inch after one day in air and six days in water, and 175 pounds per square-inch after one day in air and twenty-seven days in water.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Trenching and Backfilling." In addition meet the following requirements:

B. Exploratory Excavation: It shall be the Contractor's responsibility to excavate and locate all existing utilities which may affect construction of the sewer facilities. All exploratory excavations shall occur far enough in advance to permit any necessary relocation to be made with minimum delay. All costs incurred by the Contractor in making exploratory excavations shall be considered to be included in the unit price bid for constructing each section of sewer line or the associate structures.

3.2 UNSTABLE TRENCH BOTTOM

Where trench does not have sufficient strength to support pipe and bedding, or stream crossings are encountered, use one of following methods to prepare trench bottom as approved by the Contracting Officer. At a minimum, 2-feet of soil beneath pipe shall be stabilized.

A. Embankment: Clear and strip existing surface of all unacceptable material. Place embankment material agreed to by the Contracting Officer, compact to 98% AASHTO T99.

B. Aggregate Trench Bottom, Percent by Weight Passing Square Mesh Sieves: 1 ½", 90-100; 3/4", 50-90; No. 4, 30-50; No. 200, 3-12.

3.3 PIPING APPLICATIONS

A. Pipe couplings and special pipe 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 sewer piping, unless otherwise indicated.

a. Unshielded flexible couplings for same or minor difference OD pipes.

b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

3.4 PIPING INSTALLATION

A. Remove and dispose of existing sanitary sewer pipe where shown on drawings. Service is to be diverted and maintained during installation of the new pipeline. Pumping between manholes is acceptable.

B. Construct pipe accurately to line and grade shown on drawings. Pipe installation will be lamped daily by the Contracting Officer. Remove and replace pipe not conforming to line and grade at Contractor's expense.

C. Install per manufacturer's recommendations by placing pipe continuously upgrade. Bell ends to face upgrade. Prior to making joints, clean and dry all surfaces. Use lubricants in conformance with manufacturer's recommendations for insertion of pipe in joint. Set pipe in position and check line and grade. Keep dirt from entering all exposed pipe ends. Joints to be watertight.

D. Install proper size couplings where different materials of pipes and fittings are connected.

E. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at a slope shown on plans.

2. Install piping with 36-inch minimum cover unless otherwise indicated.

3. Install piping below frost line.

4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is

completed. Place plug in end of incomplete piping at end of day and when work stops.

G. Wyes and Risers for Service Connections: Angle upward so 1/8 bend connected to fitting will make service line invert equal to inside crown of sewer main.

H. Keep trenches free from water during pipe laying and jointing. Dewatering of trench, including rock or gravel underdrain, considered as incidental to construction and all costs shall be included in contract prices. When pipe laying is not in progress, close open ends of pipe by watertight plug, or other means approved by the Contracting Officer.

Dewatering shall be accomplished by the use of well points, sump pumps, rock or gravel drains placed below subgrade foundations or subsurface pipe drains. All water shall be disposed of in a suitable manner without being a menace to public health or causing public inconvenience. No water shall be drained into other work being completed or under construction.

The dewatering operation shall continue until such time as it is safe to allow the water table to rise in the excavations. Pipe trenches shall contain enough backfill to prevent pipe flotation.

Water shall not be allowed to rise until the concrete has set a minimum of twenty-four (24) hours, and the forms have been removed. Water shall not be allowed to rise unequally against unsupported structural walls.

Contractor shall coordinate with the Government for obtaining dewatering permit through the State as required.

3.5 UTILITIES ENCOUNTERED

A. Protection of all existing gas, water, sewer services, culverts, drains, cable, telephone lines, and electric lines encountered during construction is the Contractor's responsibility, and if utilities are disturbed, they shall be maintained and/or restored to original condition at his expense. Backfill around utilities shall be adequately compacted to assure permanent stability.

3.6 WATER LINE CROSSING

A. Normal Conditions: Whenever possible, lay sanitary sewer under water main to provide vertical separation of at least 18” between invert of water main and crown of sewer.

B. Unusual Conditions: If above separation cannot be met, use the following:

1. Sewer passing over or less than 18” under water main:

a. Install one piece of C900 PVC pipe centered over the waterline with a solid sleeve coupler with transition gaskets.

b. Install a grout collar over the two sewer joints on either side of the water crossing. The grout collar shall be around the entire perimeter of the joint and shall have 3-4 rebars around the circumference of the pipe.

c. If clearance is less than 12 inches vertically, the space between the water and sewer mains shall be filled by 3,000 psi concrete.

d. Water mains passing under sewers: If vertical separation less than 18-inches, provide structural support for sewer.

2. In all cases, bedding material shall be used to prevent any settling of the higher pipe.

3.7 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

2. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.8 CONNECTION TO EXISTING MANHOLE

A. Connect to the existing opening in the existing manhole as necessary to insert new pipe and attain watertight seal. Chip existing concrete bench inside manhole to provide enough thickness for mortar bed to make new smooth continuous invert. Place expandable waterstop around portion of sewer pipe inserted into existing manhole. Use expandable grout to completely fill hole in manhole to create watertight repair.

3.9 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use extra-heavy-duty, top-loading classification cleanouts in parking lot limits.

2. Use PVC cleanouts as indicated or in non-traffic areas.

B. Set cleanout frames and covers in paved areas with road section up to edge of pipe and then compact as specified.

C. Set cleanout frames and covers in un-paved areas 2-inches above grade.

3.10 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section.

B. Make connections to existing piping.

1. Use commercially manufactured saddle wye tap fittings for piping branch connections. Stainless steel straps shall be used full diameter to hold saddle. Existing pipe shall be core drilled full diameter of branch.

2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Existing sanitary sewer service connection: Connect the new sanitary service to the Warehouse to the existing sanitary service line 5 feet outside of the building.

3.11 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.

2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

3. Fill abandoned pipe if pipe is 15-inches or longer with sand or flowfill. Submit method utilized for the Contracting Officer’s review

4. Backfill to grade according to Division 31 Section "Trenching and Backfilling"

3.12 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Trenchingand Backfilling" Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.

2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.13 FIELD QUALITY CONTROL

A. Notify the Contracting Officer at least 24 hours in advance of pipe being laid in any trench. Cover no pipes until observed by the Contracting Officer. Notify the Contracting Officer at least 48 hours before pipe is to be tested.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24-inches of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.

b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.

c. Crushed, broken, cracked, or otherwise damaged piping.

2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

3. Reinspect and repeat procedure until results are satisfactory.

C. Leakage Test: Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects. Sewerlines shall be tested using a low-pressure air test only; water tests will not be allowed. Only after the sanitary lines, including appurtenances, and water services have been installed and backfilled to finish grade, shall the Contractor proceed with an air test on the installed facilities

1. Do not enclose, cover, or put into service before inspection and approval.

2. Low Pressure Air Test Procedure

a. The section of sewerline to be tested should be flushed and cleaned prior to conducting the low-pressure air test. This serves to clean out any debris, wet the pipe, and produce more consistent results. Isolate the section of sewerline to be tested by means of inflatable stoppers or other suitable test plugs. One of the plugs should have an inlet tap, or other provision for connecting a hose to a portable air control source.

b. If the test section is below the groundwater level, determine the height of the ground water above the spring line of the pipe at each end of the test section and compute the average. For every foot of groundwater above the pipe spring line, increase the gauge test pressure by 0.43 pounds per square inch. Connect the air hose to the inlet tap and a portable air control source. The air equipment should consist of necessary valves and pressure

gauges to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. Also, the testing apparatus should be equipped with a pressure relief device to avoid the possibility of loading the test section with the full capacity of the compressor. Locate valves and gauges above ground.

c. Add air slowly to the test section until the pressure inside the pipe is raised to 5.0 psig greater than the average backpressure of any groundwater that may be over the pipe. After a pressure of 5.0 psig is obtained, regulate the air supply so that the pressure is maintained between 4.5 and 5.0 psig (above the average ground water back pressure) for a period of 2 minutes. This allows the air temperature to stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until temperature equilibrium is obtained.

d. Determine the rate of air loss by the time/pressure drop method. After the 2 minute air stabilization period, the air supply is disconnected and the test pressure allowed decreasing to 4.5 psig. The time required for the test pressure to drop from 4.5 psig to 4.0 psig is determined by means of a stopwatch and this time interval is then compared to the required time in the attached table to determine if the rate of air loss is within the allowable time limit. If the time is equal to or greater than the times indicated in the tables, the pipeline shall be deemed acceptable.

MINIMUM DURATION FOR AIR TEST PRESSURE DROP

Pipe Size (Inches)	Time (Minutes)
4	2.5
6	4.0

e. Upon completion of the test, open the bleeder valve to allow air to escape. Plugs should not be removed until all air pressure in the test section has been released. During this time, no one should be allowed in the trench while the pipe is being decompressed.

f. Submit separate report for each test.

g. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

D. The last page of this specification section “Air Test Data Sheet” is to be utilized by the Contractor to record his test results. Other forms can be utilized if approval of the Contracting Officer is obtained prior to conducting tests. Upon request, an electronic copy of “Air Test Data Sheet” can be provided to the Contractor from the Contracting Officer.

E. Deflection Test for Non-Rigid Pipe: The maximum allowable pipe deflection for a completely backfilled, non-rigid sewer pipe shall not exceed 5 percent of the nominal internal pipe diameter. Deflections in non-rigid pipe shall be checked by measurement or by pulling a mandrel with the minimum allowable diameter through the pipe. The minimum allowable diameter shall be equal to the minimum interior diameter of the pipe, as specified in the applicable portions of the ASTM Standard Specifications or the pipe manufacturer's recommendations, minus 5 percent of the minimal interior diameter of the pipe. Those sections of non-rigid pipe with deflections greater than the maximum allowable 5 percent shall not be acceptable and the Contractor will remove and replace these sections at their own expense.

Deflection tests will be run if in the opinion of the Contracting Officer testing is warranted. The program for testing shall be mutually determined by the Contracting Officer and the Contractor. The Contractor shall furnish all labor, tools and equipment necessary to make the tests and to perform any work incidental thereto.

3.14 LOCATION OF EXISTING SERVICES

A. The Contractor is responsible for locating existing service at the warehouse.

3.15 CLEANUP AND RESTORATION

A. Restore all pavements, curbs, gutters, utilities, fences, yards, lawns, and other structures or surfaces to condition equal to or better than before work began, and to satisfaction of the Contracting Officer. Deposit all waste material off-site. Complete topsoil and reseeding of site, is required.

B. General cleanup of the area shall be performed on a daily basis to the satisfaction of the Contracting Officer. Proper safety provisions, including ropes, fence, barricades, construction signs, and warning signs, shall be maintained until completion of work.

END OF SECTION 333100

AIR TEST DATA SHEET

Owner (Name of City, District, etc) _Test No.__
Identification of Pipe Installation (Job Name, Location, Contract No. etc) _
___
___

Field Test Data: (To be filled in by the Resident)
Date:__Specified Maximum Pressure Drop: _psig
Identification of Pipe Material Installed:_
___
___

Pipe Under Test				**Specification Time**	**Field Test Operations Data**					
Up-stream Man-hole Station No.	Down-stream Manhole Station No.	Dia. D (in.)	Length L (ft.)	Refer to Table (min:sec)	Pressure Initially Raised to (psig)	Time Allowed For Pressure To Stabilize (min)	Start Test Press. (psig)	Stop Test Press. (psig)	Elapsed Time (min:sec)	Pass or Fail (P or F)

Residents Name and Title:___
Signature of Resident:

If a section fails, the following items shall be completed:
Identify section(s) that failed:
Leak (was) (was not) located. Method used:_
Description of leakage found:

Description of corrective action taken:__

For test results after repair refer to Test No. _Resident:__

This page intentionally left blank.