SPECIFICATIONS & CONTRACT DOCUMENTS FOR THE PROJECT:

A New Facility for: FIRE STATION NO. 6

FOR THE



MAYOR-PRESIDENT JOSHUA S. GUILLORY

CHIEF ADMINISTRATIVE OFFICER CYDRA WINGERTER

LAFAYETTE CITY COUNCIL PATRICK LEWIS – DISTRICT 1 ANDY NAQUIN – DISTRICT 2 LIZ W. HEBERT – DISTRICT 3 NANETTE COOK – DISTRICT 4 GLENN LAZARD – DISTRICT 5

LAFAYETTE PARISH COUNCIL BRYAN TABOR – DISTRICT 1 KEVIN NAQUIN – DISTRICT 2 JOSH CARLSON – DISTRICT 3 JOHN J. GUILBEAU – DISTRICT 4 ABRAHAM "AB" RUBIN, JR. – DISTRICT 5

DEPARTMENT OF PUBLIC WORKS-DIRECTOR CHAD NEPVEAUX

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> > PREPARED BY:



5-4-23

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DOCUMENT 000107

PROFESSIONAL SEALS PAGE

The specification sections listed below were prepared by or under the direct supervision of the Civil Engineer:

CIVIL ENGINEER

ames . Ricks, P.E. Southeast Engineers, LLC 345 Doucet Rd, Suite 102 Lafayette, LA 70503



The civil site work items on this project shall be in accordance with the 2016 Lafayette Consolidated Government Standard Specifications for Roads, Drainage, Bridges and Other Infrastructure (LCG-SSRDB). All items not covered in LCG-SSRDB shall adhere to project specifications contained herein. Should a conflict in specifications occur, the SSRB shall govern.

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SECTION 012000 PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

1.02 RELATED REQUIREMENTS

1.03 SCHEDULE OF VALUES

- A. Use Schedule of Values Form: AIA G703, edition stipulated in the Agreement.
- B. Use Schedule of Values Form: ConsensusDOCS 293, edition stipulated in the Agreement.
- C. Use Schedule of Values Form: DBIA 500-D1, edition stipulated in the Agreement.
- D. Use Schedule of Values Form: EJCDC C-620, edition stipulated in the Agreement.
- E. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.
- F. Forms filled out by hand will not be accepted.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

- A. Payment Period: Submit at intervals stipulated in the Agreement.
- B. Use Form AIA G702 and Form AIA G703, edition stipulated in the Agreement.
- C. Use Form AIA G732 and Form AIA G703, edition stipulated in the Agreement.
- D. Use Form AIA G742 and AIA G743, edition stipulated in the Agreement.
- E. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
- F. Forms filled out by hand will not be accepted.
- G. Execute certification by signature of authorized officer.
- H. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.
- I. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.
- J. Submit one electronic and three hard-copies of each Application for Payment.

1.05 MODIFICATION PROCEDURES

- A. Submit name of the individual authorized to receive change documents and who will be responsible for informing others in Contractor's employ or subcontractors of changes to Contract Documents.
- B. For minor changes not involving an adjustment to the Contract Price or Contract Time, Architect will issue instructions directly to Contractor.
- C. For other required changes, Architect will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
 - 1. The document will describe the required changes and will designate method of determining any change in Contract Price or Contract Time.
 - 2. Promptly execute the change.
- D. For changes for which advance pricing is desired, Architect will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 3 days.

- E. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
- F. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.
- G. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Price.

1.06 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Price, previous payments, and sum remaining due.

SECTION 015000 TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 015100 Temporary Utilities.
- B. Section 015213 Field Offices and Sheds.
- C. Section 015500 Vehicular Access and Parking.
- D. Section 015813 Temporary Project Signage.

1.02 DEWATERING

- A. Provide temporary means and methods for dewatering all temporary facilities and controls.
- B. Maintain temporary facilities in operable condition.
- C. Maintain temporary facilities as directed by Architect.

1.03 TEMPORARY UTILITIES - SEE SECTION 015100

- A. Owner will provide the following:
 - 1. Electrical power and metering, consisting of connection to existing facilities.
 - 2. Water supply, consisting of connection to existing facilities.
- B. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.
- C. Existing facilities may not be used.
- D. New permanent facilities may be used.

1.04 TELECOMMUNICATIONS SERVICES

- A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.
- B. Provide equivalent equipment and connections for Owner's field office.
- C. Provide equivalent equipment and connections for Architect's field office.
- D. Telecommunications services shall include:
- E. Architect will pay for own telecommunications services.

1.05 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. Maintain daily in clean and sanitary condition.

1.06 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-ofway and for public access to existing building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.07 FENCING

- A. Construction: Contractor's option.
- B. Construction: Commercial grade chain link fence.
- C. Provide 6 foot (1.8 m) high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.08 EXTERIOR ENCLOSURES

A. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.09 INTERIOR ENCLOSURES

- A. Provide temporary partitions and ceilings as indicated to separate work areas from Owneroccupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
- B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces:

1.10 SECURITY - SEE SECTION 013553

A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

1.11 VEHICULAR ACCESS AND PARKING - SEE SECTION 015500

- A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
- B. Coordinate access and haul routes with governing authorities and Owner.
- C. Provide and maintain access to fire hydrants, free of obstructions.
- D. Provide means of removing mud from vehicle wheels before entering streets.
- E. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

1.12 WASTE REMOVAL

- A. See Section 017419 Construction Waste Management and Disposal, for additional requirements.
- B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- C. Provide containers with lids. Remove trash from site periodically.
- D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.13 PROJECT SIGNS - SEE SECTION 015813

1.14 PROJECT IDENTIFICATION

- A. Provide project identification sign of design and construction indicated on drawings.
- B. Erect on site at location indicated.
- C. Erect on site at location established by Architect.
- D. No other signs are allowed without Owner permission except those required by law.

1.15 FIELD OFFICES - SEE SECTION 015213

- A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.
- B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
- C. Provide separate private office similarly equipped and furnished, for use of Owner.

- D. Provide separate private office similarly equipped and furnished, for use of Architect and Owner.
- E. Locate offices a minimum distance of 30 feet (10 m) from existing and new structures.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

SECTION 015100 TEMPORARY UTILITIES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction Current Edition.

1.02 TEMPORARY ELECTRICITY

- A. Cost: By Contractor.
- B. Provide power service required from utility source.
- C. Power Service Characteristics: 120/280 volt, hrj ampere, three phase, four wire.
- D. Provide power outlets for construction operations, with branch wiring and distribution boxes located at each floor. Provide flexible power cords as required.
- E. Provide main service disconnect and over-current protection at convenient location and meter.
- F. Permanent convenience receptacles may be utilized during construction.
- G. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.

1.03 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain LED, compact fluorescent, or high-intensity discharge lighting as suitable for the application for construction operations in accordance with requirements of 29 CFR 1926 and authorities having jurisdiction.
- B. Provide and maintain 1 watt/sq ft (10.8 watt/sq m) lighting to exterior staging and storage areas after dark for security purposes.
- C. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- D. Maintain lighting and provide routine repairs.

1.04 TEMPORARY HEATING

- A. Cost of Energy: By Contractor.
- B. Cost of Energy: By Owner.
- C. Provide heating devices and heat as needed to maintain specified conditions for construction operations.
- D. Maintain minimum ambient temperature of 50 degrees F (10 degrees C) in areas where construction is in progress, unless indicated otherwise in specifications.

1.05 TEMPORARY COOLING

- A. Cost of Energy: By Contractor.
- B. Cost of Energy: By Owner.
- C. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations.
- D. Maintain maximum ambient temperature of 80 degrees F (26 degrees C) in areas where construction is in progress, unless indicated otherwise in specifications.

1.06 TEMPORARY VENTILATION

- A. Existing ventilation equipment may not be used.
- B. Utilize existing ventilation equipment. Extend and supplement equipment with temporary fan units as required to maintain clean air for construction operations.

1.07 TEMPORARY WATER SERVICE

- A. Cost of Water Used: By Contractor.
- B. Cost of Water Used: By Owner.

C. Provide and maintain suitable quality water service for construction operations at time of project mobilization.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

SECTION 015500 VEHICULAR ACCESS AND PARKING

PART 1 GENERAL

PART 2 PRODUCTS

2.01 MATERIALS

A. Temporary Construction: Contractor's option.

PART 3 EXECUTION

3.01 ACCESS ROADS

- A. Use of existing on-site streets for construction traffic is not permitted.
- B. Use of existing on-site streets and driveways for construction traffic is permitted.
- C. Tracked vehicles not allowed on paved areas.
- D. Construct new temporary all-weather access roads from public thoroughfares to serve construction area, of a width and load bearing capacity to provide unimpeded traffic for construction purposes.

3.02 PARKING

- A. Use of existing parking facilities by construction personnel is not permitted.
- B. Use of designated areas of existing parking facilities by construction personnel is permitted.
- C. Use of new parking facilities by construction personnel is not permitted.
- D. Use of designated areas of new parking facilities by construction personnel is permitted.
- E. Arrange for temporary parking areas to accommodate use of construction personnel.

3.03 CONSTRUCTION PARKING CONTROL

A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and Owner's operations.

3.04 MAINTENANCE

- A. Maintain traffic and parking areas in a sound condition free of excavated material, construction equipment, products, mud, snow, and ice.
- B. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

3.05 REMOVAL, REPAIR

- A. Remove temporary roads when permanent paving is usable.
- B. Repair existing facilities damaged by use, to original condition.
- C. Repair damage caused by installation.

SECTION 015713 TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Prevention of erosion due to construction activities.
- B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
- C. Restoration of areas eroded due to insufficient preventive measures.
- D. Compensation of Owner for fines levied by authorities having jurisdiction due to noncompliance by Contractor.

1.02 RELATED REQUIREMENTS

- A. Section 013329.02 Sustainable Design Reporting LEED v4: Submittal requirements for sustainable design documentation.
- B. Section 321123 Aggregate Base Courses: Temporary and permanent roadways.

1.03 REFERENCE STANDARDS

- A. ASTM D4355/D4355M Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus 2021.
- B. ASTM D4491/D4491M Standard Test Methods for Water Permeability of Geotextiles by Permittivity 2022.
- C. ASTM D4533/D4533M Standard Test Method for Trapezoid Tearing Strength of Geotextiles 2015.
- D. ASTM D4632/D4632M Standard Test Method for Grab Breaking Load and Elongation of Geotextiles 2015a.
- E. ASTM D4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile 2021a.
- F. ASTM D4873/D4873M Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples 2017 (Reapproved 2021).

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Sustainable Design Documentation: Submit documentation required in this section in accordance with requirements specified in Section 013329.02.
- C. Erosion and Sedimentation Control Plan:
 - 1. Submit within 2 weeks after Notice to Proceed.
 - 2. Submit not less than 30 days prior to anticipated start of clearing, grading, or other work involving disturbance of ground surface cover.
 - 3. Include:
 - a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
 - b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.
 - c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.
 - d. Schedule of temporary preventive measures, in relation to ground disturbing activities.
 - e. Other information required by law.
 - f. Format required by law is acceptable, provided any additional information specified is also included.
 - 4. Obtain the approval of the Plan by authorities having jurisdiction.
 - 5. Obtain the approval of the Plan by Owner.

- D. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.
- E. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.
- B. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
 - 1. Average Opening Size: 30 U.S. Std. Sieve (0.600 mm), maximum, when tested in accordance with ASTM D4751.
 - 2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491/D4491M.
 - 3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
 - 4. Tensile Strength: 100 pounds-force (450 N), minimum, in cross-machine direction; 124 pounds-force (550 N), minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
 - 5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
 - 6. Tear Strength: 55 pounds-force (245 N), minimum, when tested in accordance with ASTM D4533/D4533M.
 - 7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
- C. Silt Fence Posts: One of the following, minimum 5 feet (1500 mm) long:
 - 1. Steel U- or T-section, with minimum mass of 1.33 pound per linear foot (1.98 kg per linear m).
 - 2. Softwood, 4 by 4 inches (100 by 100 mm) in cross section.
 - 3. Hardwood, 2 by 2 inches (50 by 50 mm) in cross section.
- D. Gravel: See Section 321123 for aggregate.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

- A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.
- B. Construction Entrances: Traffic-bearing aggregate surface.
 - 1. Width: As required; 20 feet (7 m), minimum.
 - 2. Length: 50 feet (16 m), minimum.
 - 3. Provide at each construction entrance from public right-of-way.
 - 4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- C. Linear Sediment Barriers: Made of silt fences.
 - 1. Provide linear sediment barriers:
 - a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.

- b. Along the top of the slope or top bank of drainage channels and swales that traverse disturbed areas.
- c. Perpendicular to flow across the bottom of existing and new drainage channels and swales that traverse disturbed areas or carry runoff from disturbed areas; space at maximum of 200 feet apart (at maximum of 60 m apart).
- 2. Space sediment barriers with the following maximum slope length upslope from barrier:
 - a. Slope of Less Than 2 Percent: 100 feet (30 m)...
 - b. Slope Between 2 and 5 Percent: 75 feet (23 m).
 - c. Slope Between 5 and 10 Percent: 50 feet (15 m).
 - d. Slope Between 10 and 20 Percent: 25 feet (7.5 m).
 - e. Slope Over 20 Percent: 15 feet (4.5 m).
- D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
 - 1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
 - 2. Straw bale row blocking entire inlet face area; anchor into pavement.
- E. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.
- F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.
- G. Soil Stockpiles: Protect using one of the following measures:
 - 1. Cover with polyethylene film, secured by placing soil on outer edges.
 - 2. Cover with mulch at least 4 inches (100 mm) thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches (150 mm) of straw or hay.
- H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
 - 1. Wood Waste: Use only on slopes 3:1 or flatter; no anchoring required.
 - 2. Asphalt: Use only where no traffic, either vehicular or pedestrian, is anticipated.
- I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

- A. Traffic-Bearing Aggregate Surface:
 - 1. Excavate minimum of 6 inches (150 mm).
 - 2. Place geotextile fabric full width and length, with minimum 12 inch (300 mm) overlap at joints.
 - 3. Place and compact at least 6 inches (150 mm) of 1 1/2 to 3 1/2 inch (40 to 90 mm) diameter stone.
- B. Silt Fences:
 - 1. Store and handle fabric in accordance with ASTM D4873/D4873M.
 - 2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch (405 mm) high barriers with minimum 36 inch (905 mm) long posts spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 4 inches (100 mm) in ground.
 - 3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch (710 mm) high barriers, minimum 48 inch (1220 mm) long posts spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
 - 4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet (6 m), use nominal 32 inch (810 mm) high barriers with woven wire reinforcement and steel posts spaced at 4 feet (1220 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
 - 5. Install with top of fabric at nominal height and embedment as specified.
 - 6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches (460 mm), with extra post.

- 7. Fasten fabric to wood posts using one of the following:
 - a. Four nails per post with 3/4 inch (19 mm) diameter flat or button head, 1 inch (25 mm) long, and 14 gauge, 0.083 inch (2.11 mm) shank diameter.
 - b. Five staples per post with at least 17 gauge, 0.0453 inch (1.150 mm) wire, 3/4 inch (19 mm) crown width and 1/2 inch (12 mm) long legs.
- 8. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
- 9. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches (300 mm) high with post spacing not more than 4 feet (1220 mm).
- C. Temporary Seeding:
 - 1. When hydraulic seeder is used, seedbed preparation is not required.
 - 2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
 - 3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft (0.5 kg per 100 sq m).
 - 4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft (6 to 8 kg per 100 sq m).
 - 5. Incorporate fertilizer into soil before seeding.
 - 6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch (12 to 25 mm) deep.
 - 7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
 - 8. Repeat irrigation as required until grass is established.

3.05 MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (13 mm) or more rainfall at the project site, and daily during prolonged rainfall.
- B. Repair deficiencies immediately.
- C. Silt Fences:
 - 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 - 2. Remove silt deposits that exceed one-third of the height of the fence.
 - 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- D. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

SECTION 015813 TEMPORARY PROJECT SIGNAGE

PART 1 GENERAL

1.01 QUALITY ASSURANCE

- A. Design sign and structure to withstand 50 miles/hr (80 km/hr) wind velocity.
- B. Sign Painter: Experienced as a professional sign painter for minimum three years.

1.02 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Shop Drawing: Show content, layout, lettering, color, foundation, structure, sizes and grades of members.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

- A. Structure and Framing: New, wood, structurally adequate.
- B. Lettering: Exterior quality paint, contrasting colors.
- C. Lettering: Pre-cut vinyl self-adhesive products, white.

2.02 PROJECT IDENTIFICATION SIGN

- A. One painted sign of construction, design, and content indicated on drawings, location designated.
- B. One painted sign, 48 sq ft (4.5 sq m) area, bottom 6 feet (2 m) above ground.
- C. Content:
 - 1. Project number, title, logo and name of Owner as indicated on Contract Documents.
 - 2. Names and titles of authorities.
 - 3. Names and titles of Architect and Consultants.
 - 4. Name of Prime Contractor and major Subcontractors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install project identification sign within 30 days after date fixed by Notice to Proceed.
- B. Erect at designated location.
- C. Install sign surface plumb and level, with butt joints. Anchor securely.

3.02 REMOVAL

A. Remove signs, framing, supports, and foundations at completion of Project and restore the area.

SECTION 020342 REMOVAL AND SALVAGE OF PERIOD CONSTRUCTION MATERIALS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 013591 - Period Treatment Procedures for general historic preservation project requirements.

1.02 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Deconstruction Crew's Qualification Statement: Documentation of three consecutive years of work of this type, including similar projects identifying when, where, and for whom the work was performed.
- C. Work Plan: Detailed, proposed instructions for each type of operation of procedures for accomplishment of deconstruction work, including detailed description of the methods and equipment to be used and sequence of operations. Include the following:
 - 1. Extent of deconstruction, removal sequences, temporary and permanent bracing and shoring, and location and construction of barricades and fences.
 - 2. Instructions for removal and disposition of period materials specified to be salvaged or recycled.
 - 3. Dust control measures.
 - 4. Protection of property to remain undisturbed.
 - 5. Ensure coordination with other work.
 - 6. Plan for sequencing and timely disconnection and reconnection of utility services.

1.03 QUALITY ASSURANCE

A. Deconstruction Crew Qualifications: Workers trained and experienced in removal and salvage of historic materials.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PERIOD TREATMENT, GENERAL

A. See Section 013591 for special procedure requirements related to elements and features of historical significance and value.

3.02 GENERAL PROCEDURES

- A. Drawings indicating existing construction, building services, and site utilities are based on casual field observation and existing record documents only.
 - 1. Report discrepancies to Architect before disturbing existing historic elements.
 - 2. Beginning of work constitutes acceptance of existing conditions that are apparent upon examination at that time.
- B. Separate spaces in which removals and salvage operations are conducted from occupied spaces.
 - 1. Provide, erect, and maintain temporary dustproof partitions; see Section 015000.
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; exercise care to prevent water and humidity damage.

3.03 ENVIRONMENTAL CONTROLS

A. Comply with federal, state, and local regulations pertaining to water, air, solid waste, recycling, chemical waste, sanitary waste, sediment, and noise pollution.

3.04 ITEMS TO BE SALVAGED

A. General: Salvage elements and components to the maximum extent possible. Maintain a chain of custody of salvaged materials, including the condition of such materials before and after salvage operations.

- 1. Remove furnishings, equipment, and materials not scheduled for salvage or recycling prior to initiating salvaging procedures.
- 2. Remove historic items to be salvaged from the structure prior to deconstruction work.
- 3. Accomplish removal of salvageable items by hand labor to the maximum extent possible.
- 4. Take care not to damage historic portions of the structure scheduled to remain or items identified for salvage.
- 5. Obtain hot work permits for removal of elements requiring use of fire- or spark-producing tools or activities that produce sources of ignition.
- B. Site Elements: Remove intact and salvage site elements indicated on drawings.
- C. Concrete Elements: Remove intact and salvage concrete elements indicated on drawings.
- D. Masonry Elements: Remove intact and salvage masonry elements indicated on drawings.
- E. Metal Elements: Remove intact and salvage metal elements indicated on drawings.
- F. Wood Elements: Remove intact and salvage wood elements indicated on drawings.
- G. Thermal and Moisture Protection Elements: Remove intact and salvage thermal and moisture protection elements indicated on drawings.
- H. Doors and Windows: Remove intact and salvage doors and windows indicated on drawings.
- I. Finishes: Protect special or historic finishes and finish elements indicated on drawings.
- J. Equipment and Specialty Elements: Remove intact and salvage specialty elements indicated on drawings.
- K. Mechanical Equipment: Remove intact and salvage equipment and fixtures indicated on drawings.
- L. Electrical Equipment: Remove intact and salvage equipment and fixtures indicated on drawings.

3.05 MATERIALS TO BE REMOVED

- A. Remove existing nonhistoric elements as indicated and as required to allow direct access to period construction elements indicated to be restored or salvaged for reuse.
- B. Services: Remove existing systems and equipment to extent indicated, including but not limited to Fire Protection, Plumbing, HVAC, Electrical, and Telecommunications elements:
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and other operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service switchover.
 - 3. Verify that abandoned services serve only abandoned facilities prior to commencing removals.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stubs and tag with identification.
- C. Protect existing historic elements.
 - 1. Prevent movement of structure; provide temporary, removable shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly, minimizing overcutting.

3.06 MATERIALS TO BE RECYCLED

- A. Recycle removed nonhistoric materials to the maximum extent possible. Remove recyclable materials by hand wherever possible.
- B. Recycle items indicated on drawings.

SECTION 024100 DEMOLITION

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 011000 Summary: Limitations on Contractor's use of site and premises.
- B. Section 015000 Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 017000 Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- D. Section 312323 Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

1.02 REFERENCE STANDARDS

- A. 29 CFR 1926 Safety and Health Regulations for Construction Current Edition.
- B. NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations 2022, with Errata (2021).

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Site Plan: Indicate:
 - 1. Areas for temporary construction and field offices.
- C. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 - 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
- D. Demolition firm qualifications.
- E. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.04 QUALITY ASSURANCE

A. Demolition Firm Qualifications: Company specializing in the type of work required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill Material: See Section 312323.

PART 3 EXECUTION

3.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 7. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 - 8. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from

removal operations.

- 9. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Do not begin removal until built elements to be salvaged or relocated have been removed.
- D. Protect existing structures and other elements to remain in place and not removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
- E. Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- F. Hazardous Materials:
 - 1. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.
 - 2. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.
- G. Perform demolition in a manner that maximizes salvage and recycling of materials.
 - 1. Dismantle existing construction and separate materials.
 - 2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

3.02 EXISTING UTILITIES

- A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.03 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
 - 1. Verify construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
- C. Remove existing work as indicated and required to accomplish new work.1. Remove items indicated on drawings.
- D. Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.

- 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
- 3. Verify that abandoned services serve only abandoned facilities before removal.
- 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
- E. Protect existing work to remain.
 - 1. Prevent movement of structure. Provide shoring and bracing as required.
 - 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch to match new work.

3.04 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

SECTION 221343 FACILITY PACKAGED SEWAGE PUMPING STATIONS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 221005 - Plumbing Piping.

1.02 REFERENCE STANDARDS

- A. ASTM A126 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- B. AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings 2021.
- C. AWWA C500 Metal-Seated Gate Valves for Water Supply Service 2019.
- D. AWWA C509 Resilient-Seated Gate Valves for Water Supply Service 2015.
- E. HI M100 HI Pump Standards Set 2018.
- F. ISO 2858 End-Suction Centrifugal Pumps (Rating 16 Bar) -- Designation, Nominal Duty Point and Dimensions 1975.
- G. ISO 5199 Technical Specifications for Centrifugal Pumps Class II 2002.
- H. ISO 21940-11 Mechanical Vibration -- Rotor Balancing -- Part 11: Procedures and Tolerances for Rotors with Rigid Behaviour 2016.
- I. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- J. NEMA MG 1 Motors and Generators 2021.
- K. NFPA 70 National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's technical literature for prefabricated assemblies and pump chamber and access way; include installation instructions.
- C. Shop Drawings: Detailed drawings of entire pumping station, combining components furnished by different manufacturers, if any.
- D. Sustainable Design Documentation: Amount of cement replaced by alternative materials.
- E. Source quality control test report.
- F. Field quality control test reports.
- G. Maintenance Materials:

1.04 QUALITY ASSURANCE

1.05 WARRANTY

A. Warranty: Provide manufacturer's warranty for packaged pump station, with itemized list of components covered by warranty; include list of specific operation and maintenance procedures that are required to keep warranty valid.

PART 2 PRODUCTS

2.01 PACKAGED WASTEWATER PUMPING STATIONS

- A. Packaged Wastewater Pumping Stations: Pre-engineered duplex sewage pump station, including wet well/pump chamber construction, access way(s), valves, internal piping, internal wiring, controls, and other necessary components for continuous, unattended, automatic operation.
 - 1. Furnish all components factory-assembled to greatest extent possible; where field installation is required, provide piping, wiring, and other components as required for a complete installation.

- 2. Configuration: Wet well and access way, with pump(s) submerged in wet well, surface hatch; no above grade components.
- 3. Configuration: Wet well and access way, separate below grade pump chamber; surface hatches for both; controls in pump chamber; no above grade components.
- 4. Configuration: Wet well and access way, surface hatch; pumps and controls mounted at grade in weatherproof enclosure provided as part of packaged equipment.
- 5. Service Life: 15 years.
- 6. Pumping Capacity
- 7. Total Head:
- 8. Finish all components in accordance with manufacturer's standard practice for sewage resistance.
- B. Dimensions:
 - 1. Wet Well Inside Diameter: 42 inches (1067 mm), minimum.
 - 2. Inlet and discharge sizes and elevations as indicated on drawings.
- C. Pump Lifting Assembly: Factory-assembled, mounted in wet well, designed to allow each pump to be independently raised to ground level for maintenance and returned to position without entering wet well; vertical rails, pump support assembly sliding on rails, integral guide bracket on pump, pump quick disconnect with hydraulic sealing flange, discharge pipe supports, and lifting chain; all metal parts stainless steel or bronze.
- D. Anchors and Fasteners: Stainless steel.
- E. Identification: For each item of equipment, provide the manufacturer's name or trademark and model number on corrosion-resistant identification plate, cast integrally, stamped, or otherwise permanently marked in conspicuous place; for pumps, include pump capacity in gpm and Lpm, pump head in feet and meters, speed of rotation, and direction of rotation.

2.02 PUMPS

- A. Sewage Solids-Handling Pumps: Non-clogging submersible centrifugal pump designed to pump unscreened sewage and capable of passing 3 inch (76 mm) solids.
 - 1. Capable of operating in partially submerged condition.
 - 2. Comply with HI M100.
 - 3. Rated Capacity: As indicated.
 - 4. Pump Speed: Not greater than 1,800 revolutions per minute.
- B. Sewage Grinder Pumps: Non-clogging submersible centrifugal pump capable of grinding all materials found in normal domestic sewage including plastics, rubber, sanitary napkins, disposable diapers, and wooden articles, into finely ground slurry with particle dimensions no greater than 1/4 inch (6 mm).
 - 1. Capable of operating in partially submerged condition.
 - 2. Comply with ISO 2858 and ISO 5199.
 - 3. Rated Capacity: As indicated.
 - 4. Pump Speed: Not greater than 1,800 revolutions per minute.
 - 5. Integral legs providing sufficient clearance under pump for solids to get into grinder.
- C. Pump Construction:
 - 1. Body: Cast iron, designed to permit easy replacement of parts; internal passageways permitting smooth flow of sewage and free from sharp turns and projections; cleanout plates in suction line and drain plugs; all joints gasketed.
 - 2. Impellers: Cast iron, cast steel, or other alloy suitable for sewage service; free flowing, with necessary clearance to permit objects in sewage to pass; keyed, splined, or threaded onto shaft and locked in such manner that lateral movement is prevented and reverse rotation cannot cause loosening.
 - 3. Shafts: High-grade steel, of size and strength required.
 - 4. Shaft Sleeves: Protect shaft from liquid being pumped, points in contact with stuffing boxes, and other wearing parts with sleeves of bronze or other suitable alloy.
 - 5. Shaft Seals: Mechanical seals of double carbon and ceramic construction with mating surfaces lapped to flatness tolerance of one light band, held in position with stainless steel

spring.

- 6. Shaft Seals: Stuffing box, grease-sealed with seal ring, designed to ensure tight packing without excessive wear or friction on shafts and to prevent the leakage of air or water; split type glands that can be easily removed for repacking.
- 7. Couplings: Heavy-duty flexible type couplings, keyed to the shaft; for vertical pumps provide universal type couplings.
- 8. Balance: Balance rotating parts mechanically and hydraulically to operate throughout required range without excessive end thrust, vibration, and noise; vibration not to exceed that specified in ISO 21940-11, Table 1; pumps dependent upon hydraulic balance are prohibited.
- 9. Bearings: Ball thrust bearings or roller type bearings of adequate size to withstand imposed loads; self-lubricating permanently sealed.
 - a. Grease Lubrication: Manufacturer's standard grease fittings.
- 10. Provide pump seal failure indication.
- D. Motors: Hermetically sealed, direct-coupled on pump shaft in same shell; NEMA MG 1.
 - 1. Capacity: Not less than pump at any point on pump performance curve.
 - 2. Bearings: Self-lubricating permanently sealed ball or roller type main bearings to withstand radial and end thrust.
 - 3. Power Cable: Flexible metal and neoprene-covered; seal power cable inside motor end bell.

2.03 VALVES

- A. Valves: Provide one gate valve and one check valve on each pump discharge line.
- B. Gate Valves:
 - 1. Type: Outside-screw-and-yoke rising-stem type with flanged connections; AWWA C500 with double disc gates, or AWWA C509.
 - 2. Provide valves with hand wheels that open by counterclockwise rotation.
 - 3. Provide with stuffing boxes that permit easy removal of parts for repair.
 - 4. Use valves from only one manufacturer.
- C. Check Valves:
 - 1. Rated Working Pressure: 175 psi (1.21 MPa).
 - 2. Sizes Less Than 4 inch (100 mm, DN): Neoprene ball check valve with integral hydraulic sealing flange.
 - 3. Sizes 4 inch (100 mm, DN) and Larger: Non-clogging, positive horizontal swing check type valve capable of passing 3 inch (80 mm, DN) diameter solids; ASTM A126 cast iron body.
 - a. Bronze gate, gate seats, shaft, studs, and nuts.
 - b. Buna-N disc and integral seat.
 - c. Flanged ends complying with AWWA C110/A21.10.
 - d. Removable cover for inspection and removal of gate assembly.

2.04 PIPING

- A. Inlet and Outlet Piping: Same type of pipe and jointing as specified for sanitary sewer to which pump station will be connected.
- B. Inlet and Outlet Piping: See Section 221005.
- C. Use flanged connections for exposed piping and mechanical connections for buried piping.
- D. Terminate discharge lines 5 feet (1.5 m) outside wet well.
- E. Internal Piping: Ductile iron, PVC, or CPVC; see Section 221005.
 - 1. Manufacturer's standard jointing system.
 - 2. Fittings of pressure rating not less than that of pipe.
 - 3. Separate piping of dissimilar metals with rubber gasket or other approved type of insulating joint or dielectric coupling to effectively prevent metal-to-metal contact between adjacent sections of piping.

- F. Accessories: Provide fittings, flanges, connecting pieces, transition glands, transition sleeves, and other adapters as required.
- G. Flexible Flanged Couplings: As indicated.1. Rated Working Pressure: 350 psi (2.41 MPa).

2.05 ROOM VENTILATION

- A. Provide exhaust blower capable of achieving complete air change every 5 minutes.
- B. Provide vent to atmosphere with covers and screens to prevent entrance of rain, insects, and rodents.
- C. Automatically actuate blower upon opening hatch cover, unless overridden by manual control.
- D. Mount manual and automatic switches on inside of access way within reach from outside hatch.

2.06 ROOM DEHUMIDIFIER

A. Provide packaged dehumidifier as recommended by pump station manufacturer; include controls for humidistat and low-temperature cutout; discharge condensate to wet well.

2.07 PUMP AND LEVEL CONTROL PANEL

- A. Control Panel:
 - 1. Factory sized, wired, and tested assembly within NEMA 250 Type 4X hinged door enclosure.
 - 2. Hand-Off-Auto selectable switch with illuminated green start and red stop switches.
 - 3. Mushroom type emergency stop switch interconnected with open fault auxiliary contacts for field installed safeties. Include audio-visual panel alarm and fault indicators.
 - 4. Adjustable on delay and off delay pump relays tied to pump starter interface contacts.
 - 5. Identification Plate:
 - a. Engraved plate to show uppercase white letters on black background.
 - b. 1st Line: PUMP AND LEVEL CONTROL PANEL.
 - c. 2nd Line: System Voltage (e.g. 208V, 3PH or 480V, 3PH) listing power source.
- B. Control Panel Interface:
 - 1. Provide field-installed pilot-operated solenoid valve with limit switch.
 - 2. Provide control-panel mounted pump starter.
 - 3. Provide wiring to field-installed remote pump starter.
 - 4. Provide field-installed level switch.

2.08 INSTRUMENTATION AND CONTROLS

- A. Automatic Controls: Provide automatic controls for pump and other equipment operation, with local manual controls.
 - 1. Provide manual controls as indicated.
 - 2. Provide remote indication corresponding to all local indication.
 - 3. Provide remote controls corresponding to all manual controls.
- B. Pump Controls: Provide controls capable of operating pumps either simultaneously or individually, depending on load conditions.
 - 1. Pump Actuators: Two float-operated water level switches, one float set at low-water level and one at high-water level.
 - 2. Pump Actuator: Submersible pressure type level sensor.
 - 3. When low-water level is exceeded, start the Lead pump.
 - 4. Each time low-water level is reached, set the other pump as Lead.
 - 5. Operate both pumps if water level rises above high-water level.
 - 6. Prevent both pumps from starting at the same time.
 - 7. Include time delay devices so that pumps cannot be started within a certain period after shutdown, adjustable from 10 to 120 seconds.
 - 8. Stop both pumps when low-water level is reached.
 - 9. Provide Hand-Off-Auto switches for each pump.
 - 10. If one pump is disabled, switch operation to other pump.

- 11. Include alarm to warn of failure of pumps.
- C. Pump Controls: Provide float-operated water level switch to start and stop pump.
- D. Pump Elapsed Time Meters: LCD display indicating run time in hours, not resettable; 120 volts AC.
- E. Float Type Water Level Sensors: Direct acting float switch consisting of normally-open mercury switch enclosed in tear-drop shaped float designed to tilt and operate switch sending signal; 12 volts DC.
 - 1. Pump Control Float Switches: Connected to pump controller.
 - 2. Emergency High Level Float Switch: Connected to alarm contact of battery charger to activate alarm.
 - 3. Rating: Intrinsically safe for NFPA 70 Class I, Division 1, hazardous installations.
 - 4. Float: Molded, rigid high-density polyurethane foam, color-coded and coated with durable, water and corrosion-resistant jacket of clear urethane.
 - 5. Mounting: Pole-mounted with connecting power cable.
 - 6. Junction Box: Cast aluminum, NEMA 250 compliant Type 4 enclosure, with gasketed cover and tapped float fitting and pipe threaded conduit entrance opening.
 - 7. Mount floats at elevations indicated.
- F. Pressure Type Water Level Sensors: 24 volt DC silicon oil-filled submersible pressure type level sensor/transmitter powered by and providing input to electronic pump controller, suspended on cable in wet well.
 - 1. Outputs: 4 to 20 mA, 2 wire, proportional to water level.
 - 2. Provide manufacturer's recommended mounting accessories.
 - 3. Select sensor range based on wet well depth.
 - 4. All exposed parts of TP316 stainless steel.
 - 5. Mounting: Suspend sensor on cable inside pipe that extends from under lid of wet well to bottom of wet well.
 - 6. Mounting Pipe: Schedule 40 PVC, 2 inches (50 mm) diameter, with bottom 12 inches (300 mm) perforated with 3/8 inch (9.5 mm) holes spaced 1 inch (25.4 mm).
- G. Emergency High Level Alarm: Float-operated water level switch independent of pump control; set at emergency high-water level; activating alarm indicators.
- H. No-Flow Switches: Limit switch at check valve; indicator light; activating alarm indicators.
- I. Electronic Pump Controllers: Mount in starter panel enclosure, visible with enclosure door opened in front of swing-out panel.
 - 1. Inputs: 4 to 20 mA, 2 wire level signals.
 - 2. Input Indications: Indicate wet well level digitally in direct engineering units, feet and meters.
 - 3. Outputs: Pump control outputs, with independent adjustment for each pump starting and stopping setpoint.
 - 4. Output Indication: Indicate each level setpoint digitally in direct engineering units, feet and meters.
 - 5. For each pump, provide Hand-Off-Auto switch and On-Off indicating light.

2.09 POWER

- A. Electrical Power Available: As indicated on drawings.
- B. Electrical Power Available: 120 volts AC, single phase, 60 Hz.
- C. Wiring and Conduit: Meet or exceed requirements of NFPA 70.
- D. Control Wiring: 18 AWG, minimum, in plastic wireway with snap-on cover, bundled and tie wrapped neatly.
- E. Hazardous Locations: Where pumps are specified to be explosion proof, provide pump power and control installation that meets NFPA 70 requirements for Class 1, Division 1, Group D Hazardous Location, including intrinsically safe controls, with components that are UL listed or FM approved.

- F. Control Panel: NEMA 250 compliant enclosure; 3R, Type 300 series stainless steel construction, with hinged door and hinged dead front; sized to accommodate all components; factory wired and tested.
 - 1. Internal Wiring: Stranded copper conductors rated at 194 degrees F (90 degrees C), with conductor terminations as recommended by device manufacturer.
 - 2. Mounting: Wall mounted, suitable for mounting on strut or channel.
 - 3. Door: Minimum 180 degrees opening, rubber gasket weatherproof seal, 3-point latch, and padlockable handle.
 - 4. Dead Front: Minimum of 150 degrees opening.
 - 5. Back Plate: Steel sheet, 12 gauge (0.1046 inch) (2.66 mm) thick, minimum; finished with primer coat and two coats of baked on white enamel.
 - 6. Hardware Mounting: Use machine screws in thread-tapped holes; sheet metal screws not permitted.
 - 7. Ventilator: Rain and vermin proof ventilator of fire retardant thermoplastic, located near top of enclosure on opposite side from receptacle.
 - 8. Permanently identify all devices as they are indicated on final as-built drawings; identify on front of door, front of dead front, and on back plate.
 - 9. Identify all control conductors with wire markers at each end as close as practical to end of conductor.
- G. Provide the following, at minimum, mounted on or in panel door:
 - 1. Alarm indication.
 - 2. Identification Plate: Engraved to show uppercase white letters on black background, reading:
 - a. "LIFT STATION CONTROL PANEL".
 - b. System voltage (e.g. 208V, 3PH or 480V, 3PH).
 - c. Power source.
- H. Circuit Breakers: Indicating type, quick-make quick-break thermal magnetic breakers; operating handle with On-Trip-Off positions, with Trip in middle position; inverse time characteristics through use of bimetallic tripping elements supplemented by magnetic trip for instantaneous protection; overload on one pole automatically trips and opens all legs; field installed handle ties not permitted.
- I. Motor Starters: Open frame, across the line, full voltage, NEMA rated with individual overload protection for each phase; starter contact and coil replaceable from front of starter without removing from its mounted position.
- J. Motor Overload Protection: Melting alloy type thermal overload relays; interchangeable and sized in accordance with NFPA 70.
- K. Control Transformers: Fused transformers and grounded secondaries.
- L. Surge Protection: Provide incoming power solid state devices with LED indicator lights for power and protective status.
- M. Power Monitor: Line voltage rated, solid-state, adjustable, plug-in monitor to sense reversed or loss of a phase, de-energizing upon sensing any faults and automatically restoring service upon return to normal power; activate alarm indications upon loss of normal power.
- N. Alarm Indicators: Alarm light and horn mounted on exterior of power enclosure.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install as indicated, in accordance with drawings and manufacturer's instructions.
- B. Where equipment is mounted on concrete, grout attachments before connecting piping.
- C. Set water level controls at elevations indicated; if not indicated, obtained Owner's instructions as to levels.
- D. Attach final as-built drawings of components in wet well, components above ground, and controls, laminated in mylar, to inside of pump station front door; include legends and pump

nameplate data.

E. Install on or near pump station, complete package of posted instructions, consisting of labels, signs, and operating instructions.

3.02 MANUFACTURER FIELD SERVICES

A. Provide the services of equipment manufacturer's technical representative to direct startup of station and instruct Owner's personnel in startup, operation, and maintenance procedures.

3.03 FIELD QUALITY CONTROL

SECTION 310519 GEOSYNTHETICS FOR EARTHWORK

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 312316.13 Trenching.
- B. Section 312323 Fill.

1.02 REFERENCE STANDARDS

- A. AASHTO M 288 Standard Specification for Geosynthetic Specification for Highway Applications 2022.
- B. ASTM D4355/D4355M Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus 2021.
- C. ASTM D4491/D4491M Standard Test Methods for Water Permeability of Geotextiles by Permittivity 2022.
- D. ASTM D4632/D4632M Standard Test Method for Grab Breaking Load and Elongation of Geotextiles 2015a.
- E. ASTM D4716/D4716M Standard Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head 2020.
- F. ASTM D4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile 2021a.
- G. ASTM D4833/D4833M Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products 2007 (Reapproved 2020).
- H. ASTM D4886 Standard Test Method for Abrasion Resistance of Geotextiles (Sandpaper/Sliding Block Method) 2018.
- I. ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics 2012 (Reapproved 2019).
- J. ASTM D6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe 2014.
- K. ASTM D6637/D6637M Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method 2015.
- L. ASTM D7005/D7005M Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites 2016.
- M. ASTM D7179 Standard Test Method for Determining Geonet Breaking Force 2018.
- N. ASTM D7737/D7737M Standard Test Method for Individual Geogrid Junction Strength 2015.
- O. GRI GM13 Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes 2021.
- P. GRI GM17 Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes 2021.
- Q. GRI GM32 Geomembrane Seaming Using Data Acquisition Hot Wedge Welding Devices 2019.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data on each product to be used, including physical properties, seaming materials, and installation instructions.
- C. Shop Drawings:
 - 1. Indicate overall layout, dimensions, geotextile sheet and seam layout.
 - 2. Indicate anchorage, penetration, and seaming details.

- D. Manufacturer's Certification: Indicating the proposed geosynthetic function meets design requirements supported by applicable testing results.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.01 GEOSYNTHETIC

- A. Provide geosynthetic in largest size sheets as possible to minimize field joining.
- B. Uniform thickness according to ASTM D5199.
- C. Ultraviolet Stability: 65 percent, minimum, when tested in accordance with ASTM D4355/D4355M.
- D. Abrasion Resistance: 80 percent loss for 250 cycles, when tested in accordance with ASTM D4886.

2.02 GEOTEXTILE

- A. General:
 - 1. Material: Polyethylene consisting of 5 percent maximum regrind and free of contaminants.
 - 2. AASHTO M 288.
 - 3. Elongation: 35 percent, minimum, when tested in accordance with ASTM D4632/D4632M.
- B. Geotextile for Separation: Capable of restricting adjacent material mixing.
 - 1. Type: Woven.
 - 2. Seams: Loose laid.
 - a. Overlap: According to manufacturer.
 - 1) 12 inches (300 mm), minimum, in all directions.
 - 3. Grab Strength: 300 lb (1.3 kN), minimum, when tested in accordance with ASTM D4632/D4632M.
 - 4. Puncture Strength: 450 lb (2.0 kN), minimum, when tested in accordance with ASTM D4833/D4833M.
- C. Geotextile for Filtration: Capable of allowing liquid passage while restricting solids.
 - 1. Type: Nonwoven.
 - 2. Seams: Mechanically sewn.
 - a. Overlap: 3 inches (7.6 cm).
 - b. Stitch: Flat; continuous; tied off at ends.
 - 3. Grab Strength: 300 lb (1.3 kN), minimum, when tested in accordance with ASTM D4632/D4632M.
 - 4. Permittivity: 0.5 per second, minimum, ASTM D4491/D4491M.
 - 5. Apparent Opening Size: No.40 (0.425 mm), maximum, when tested in accordance with ASTM D4751.
 - 6. Sewn Seam Strength: 275 lb (1.25kN), minimum, when tested in accordance with ASTM D4632/D4632M.
- D. Geotextile for Protection: Capable of absorbing and dissipating stress.
 - 1. Type: Woven.
 - 2. Seams: Mechanically sewn.
 - a. Overlap: 3 inches (7.6 cm).
 - b. Stitch: Flat; continuous; tied off at ends.
 - c. Limit seams perpendicular to the direction of incline.
 - 3. Grab Strength: 500 lb (2.2 kN), minimum, when tested in accordance with ASTM D4632/D4632M.
- 4. Puncture Strength: 650 lb (2.9 kN), minimum, when tested in accordance with ASTM D6241.
- E. Geotextile Accessories:
 - 1. Seaming Thread: High-strength; as recommended by manufacturer; contrasting color.
 - 2. Anchoring Pins: Steel; 18-inch (45-cm) length, 3/16-inch (4.8-mm) diameter.
 - 3. Anchoring Pins: As recommended by manufacturer.

2.03 GEOGRID

- A. General:
 - 1. Material: Polyethylene consisting of 5 percent maximum regrind and free of contaminants.
 - 2. Tensile Strength at 2 percent Strain: 400 lb/ft (5.8 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.
 - 3. Tensile Strength at 5 percent Strain: 800 lb/ft (11.7 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.
- B. Geogrid for Stabilization: Capable of reducing deformation of unbound granular materials.
 - 1. Seams: Loose laid.
 - a. Overlap: 12 inches (300 mm).
 - 2. Ultimate Tensile Strength: 1,300 lb/ft (19.0 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.
 - 3. Junction Strength: 25 lb (0.11 kN), minimum, when tested in accordance with ASTM D7737/D7737M.
- C. Geogrid for Reinforcement: Capable of increasing tensile strength of soils.
 - 1. Seams: Spliced.
 - a. Overlap: 4 inches (10 cm).
 - b. Splice: Fusion wedge welding.
 - 2. Ultimate Tensile Strength: 4,000 lb/ft (58.4 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.
 - 3. Junction Strength: 50 lb (0.22 kN), minimum, when tested in accordance with ASTM D7737/D7737M.
- D. Geogrid Accessories:
 - 1. Seaming Splices: Bodkin connection.
 - 2. Anchoring Staples: Steel; 8-inch (20-cm) length, 1-inch (2.54-cm) width.
 - 3. Anchoring Staples: As recommended by manufacturer.

2.04 GEOCOMPOSITE

- A. Geocomposite for Drainage: Capable of collecting and transmitting liquids.
 - 1. Material: Polyethylene consisting of 5 percent maximum regrind and free of contaminants.
 - 2. Fabrication: Prefabricated.
 - 3. Component Bond Strength: 0.5 lb/in (0.09 N/mm), minimum, when tested in accordance with ASTM D7005/D7005M.
 - 4. Transmissivity: 5.0 gpm/ft (0.001 m3/s/m), minimum, when tested in accordance with ASTM D4716/D4716M.
 - 5. Geonet Component: Faced on one side with geotextile.
 - a. Thickness: 0.2 inch (5 mm) when tested in accordance with ASTM D5199.
 - b. Breaking Force: 250 lb (1.05 kN), minimum, when tested in accordance with ASTM D7179.
 - c. Side Seams: Cable tied.
 - 1) Overlap: 4 inches (10 cm).
 - d. End Seams: Cable tied.
 - 1) Overlap: 12 inches (300 mm).
 - 6. Geotextile Component: Attached to geonet.
 - a. Type: Nonwoven.
 - b. Seams: Mechanically sewn.
 - 1) Overlap: 12 inches (300 mm).

- 2) Stitch: Flat; continuous; tied off at ends.
- c. Grab Strength: 200 lb (0.8 kN), minimum, when tested in accordance with ASTM D4632/D4632M.
- d. Elongation: 50 percent minimum, when tested in accordance with ASTM D4632/D4632M.
- e. Apparent Opening Size: No.70 (0.212 mm), maximum, when tested in accordance with ASTM D4751.
- B. Geocomposite Accessories:
 - 1. Seaming Splices: Plastic fasteners, contrasting color.
 - 2. Seaming Thread: High-strength; polyester thread; contrasting color.
 - 3. Anchoring Pins: Steel; 18-inch (45-cm) length, 3/16-inch (4.8-mm) diameter.
 - 4. Anchoring Pins: As recommended by manufacturer.

2.05 GEOMEMBRANE

- A. Geomembrane for Barrier: Capable of preventing fluid passage.
 - 1. PVC Liner: Scrim-reinforced plastic sheet.
 - a. Thickness: 60 mils, 0.06 inch (1.5 mm).
 - b. Scrim: Polyester, 6 by 6, 100 denier (0.011 g per m).
 - c. Overall Thickness: 60 mils, 0.06 inch (1.5 mm).
 - 2. HDPE Liner: Plastic sheet, comply with GRI GM13.
 - a. Thickness: 60 mils, 0.06 inch (1.5 mm).
 - b. Sided: Single.
 - c. Finish: Smooth.
 - 3. LDPE Liner: Plastic sheet, comply with GRI GM17.
 - a. Thickness: 60 mils, 0.06 inch (1.5 mm).
 - b. Sided: Single.
 - c. Finish: Smooth.
 - 4. Seams: Thermal fusion.
 - a. Overlap: 6 inches (150 mm), minimum.
 - b. Thermally Fused Seams:
 - 1) Single hot wedge, according to GRI GM32.
- B. Geomembrane Accessories:
 - 1. Seaming Adhesive: As recommended by manufacturer and compatible with material being seamed.
 - 2. Prefabricated Liner Penetrations: Provide manufacturer's standard factory fabricated penetration assemblies, of same base material as liner and at least 60 mils, 0.06-inch (1.5 mm) thick.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify the receiving surface is smooth, without ruts or protrusions, and grades are according to design drawings.
- B. Verify the receiving surface is unsaturated and free of ponded water.
- C. Verify the geosynthetic is free of defects or flaws that may degrade physical performance.
- D. Verify that each geosynthetic member is uniquely marked identifying proper placement.

3.02 INSTALLATION

- A. General:
 - 1. Notify Architect a minimum of 24 hours prior to installation.
 - 2. Prevent surface drainage from eroding under geosynthetic. Repair undermined areas prior to backfill.
 - 3. Position geosynthetic smooth and wrinkle free on prepared surface; unroll or unfold carefully, avoiding stretching.
 - 4. Secure geosynthetic to prevent movement or damage during installation.

- 5. Perform seaming in adequate lighting. Seam each geosynthetic member immediately after final placement. Clean sheets of dust, dirt, and other foreign matter prior to seaming.
- 6. Follow manufacturer's recommended installation procedures.
- B. Separation:
 - 1. Install geotextile according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of construction.
 - 3. Place adjacent geotextile and loosely fasten until seamed.
 - 4. Repairs: Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions.
- C. Filtration:
 - 1. Install geotextile according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of construction.
 - 3. Place adjacent geotextile and loosely fasten until seamed.
 - 4. Protect geotextile from surface runoff contamination prior to backfill.
 - 5. Repairs: Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions. Replace geotextile where surface runoff contamination has occurred.
- D. Protection:
 - 1. Install geotextile according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of incline.
 - 3. Place adjacent geotextile and loosely fasten until seamed.
 - 4. Anchor Trench:
 - Excavate with rounded corners, remove vegetation, boulders, and rocks larger than 3/4 inch (20 mm) in size, and other sharp objects in accordance with Section 312316.13.
 - 5. Place terminal ends within anchor trench and secure with backfill.
 - 6. Repairs: Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions.
- E. Stabilization:
 - 1. Install geogrid according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of construction.
 - 3. Allow geogrid to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
 - 4. Place adjacent geogrid and loosely fasten until seamed.
 - 5. Repairs: Remove damaged portion of geogrid and seam an additional layer to cover the affected area in all directions.
- F. Reinforcement:
 - 1. Install geogrid according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of reinforcement.
 - 3. Allow geogrid to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
 - 4. Place adjacent geogrid and loosely fasten until seamed.
 - 5. Penetrations:
 - a. Only cut transverse members for penetration sizes smaller than longitudinal members.
 - b. Reinforce cut geogrid longitudinal members by splicing to adjacent members.
 - 6. Anchor Trench:
 - a. Excavate in accordance with Section 312316.13.
 - 7. Place terminal ends within anchor trench and secure with backfill.
 - 8. Repairs: Remove damaged portion of geogrid and seam an additional layer to cover the affected area in all directions.
 - 9. Tensioning:
 - a. Pull geogrid taut in the direction of reinforcement to remove slack.
 - b. Ensure positive load transfer of perpendicular seams and re-seam loose connections.
- G. Drainage:

- 1. Install geocomposite according to manufacturer's recommendations.
- 2. Lay sheets in the direction of incline.
- 3. Allow geocomposite to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
- 4. Place adjacent geocomposite and loosely fasten until seamed.
- 5. Penetrations:
 - a. Seam geotextile apron to conveyances.
 - b. Apron: 2 ft (61 cm) in the direction of flow.
- 6. Anchor Trench:
 - a. Excavate in accordance with Section 312316.13.
- 7. Place terminal ends within anchor trench and secure with backfill.
- 8. Repairs:
 - a. Remove damaged portion of geonet and end seam an additional layer to cover the affected area in all directions.
 - b. Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions.

H. Barrier:

- 1. Install geomembrane according to manufacturer's recommendations.
- 2. Lay sheets in the direction of incline.
- 3. Allow geomembrane to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
- 4. Place adjacent geomembrane and loosely fasten until seamed.
- 5. Penetrations:
 - a. Seam geomembrane apron to conveyances.
 - b. Apron: 12 inches (300 mm) in the direction of flow.
- 6. Anchor Trench:
 - a. Excavate in accordance with Section 312316.13.
- 7. Place terminal ends within anchor trench and secure with backfill.
- 8. Repairs: Remove damaged portion of geomembrane and seam an additional layer to cover the affected area in all directions.

3.03 BACKFILL

- A. Obtain approval for geosynthetic sheet installation from Architect before placing fill.
- B. Backfill in a manner to prevent damage to geosynthetic. Repair geosynthetic damaged during backfill operations.
- C. Cover geosynthetic in the installed direction in accordance with Section 312323.

3.04 PROTECTION

- A. Do not exceed geosynthetic manufacturer's recommended exposure to UV radiation.
- B. Prevent surface water runoff from contaminating geosynthetic.
- C. Do not use pins or staples where risk of damaging underlying geosynthetic layer is present.
- D. Erect barricades to prevent traffic over geosynthetic before it is filled.

SECTION 311000 SITE CLEARING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 011000 Summary: Limitations on Contractor's use of site and premises.
- B. Section 015000 Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 017000 Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.
- D. Section 312200 Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.
- E. Section 329300 Plants: Relocation of existing trees, shrubs, and other plants.

1.02 SUBMITTALS

- A. Site Plan: Showing:
 - 1. Vegetation removal limits.
 - 2. Areas for temporary construction and field offices.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill Material: As specified in Section 312200 - Grading

PART 3 EXECUTION

3.01 SITE CLEARING

- A. Comply with other requirements specified in Section 017000.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 VEGETATION

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
- B. Do not begin clearing until vegetation to be relocated has been removed.
- C. Do not remove or damage vegetation beyond the limits indicated on drawings.
- D. Install substantial, highly visible fences at least 3 feet high (at least 1 m high) to prevent inadvertent damage to vegetation to remain:
 - 1. At vegetation removal limits.
 - 2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
- E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.
- F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
 - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 - 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).
 - 3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
- G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.03 DEBRIS

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

SECTION 312200 GRADING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 312323 - Fill: Filling and compaction.

1.02 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: See Section 312323.
- B. Topsoil : Complying with State of Louisiana, Highway Department standards.
- C. Topsoil: Topsoil excavated on-site.
 - 1. Graded.
 - 2. Free of roots, rocks larger than 1/2 inch (12 mm), subsoil, debris, large weeds and foreign matter.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.
- B. Verify the absence of standing or ponding water.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.

3.03 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
- D. Do not remove wet subsoil , unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform work by hand and cut roots with sharp axe.
- F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- G. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 SOIL REMOVAL

- A. Stockpile excavated topsoil on site.
- B. Stockpile topsoil to be re-used on site; remove remainder from site.
- C. Remove excavated topsoil from site.
- D. Stockpile excavated subsoil on site.
- E. Stockpile subsoil to be re-used on site; remove remainder from site.
- F. Remove excavated subsoil from site.

G. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet (2.5 m); protect from erosion.

3.05 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1/2 inch (13 mm) in size. Remove soil contaminated with petroleum products.
- C. Where topsoil is to be placed, scarify surface to depth of 3 inches (75 mm).
- D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches (75 mm).
- E. Place topsoil where required to level finish grade.
- F. Place topsoil to thickness as indicated.
- G. Place topsoil during dry weather.
- H. Remove roots, weeds, rocks, and foreign material while spreading.
- I. Near plants spread topsoil manually to prevent damage.
- J. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- K. Lightly compact placed topsoil.
- L. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.06 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) (30 mm) from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch) (13 mm).

3.07 FIELD QUALITY CONTROL

A. See Section 312323 for compaction density testing.

SECTION 312316 EXCAVATION

PART 1 GENERAL

1.01 PRICE AND PAYMENT PROCEDURES

- A. See Section 012200 Unit Prices, for general requirements applicable to unit prices for excavation.
- B. Unit Price: Excavating Soil Materials.
 - 1. Measurement Method: By the cubic foot (cubic meter).
 - 2. Includes: Excavating to required elevations, loading and placing materials in stockpile, and dewatering.
 - 3. Does Not Include Over-Excavation: Payment will not be made for over-excavated work nor for replacement materials.

1.02 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Temporary Support and Excavation Protection Plan.
- C. Project Record Documents: Record drawings at project closeout according to 017000 -Execution and Closeout Requirements. Show locations of installed support materials left in place, including referenced locations and depths, on drawings.
- D. Shoring Installer's Qualification Statement.
- E. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

1.04 QUALITY ASSURANCE

- A. Temporary Support and Excavation Protection Plan:
 - 1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
 - 2. Include drawings and calculations for bracing and shoring.
 - 3. Bracing and shoring design to meet requirements of OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
- B. Designer Qualifications: For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in Louisiana.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bedding and Fill to Correct Over-Excavation:
- B. Underground Warning Tapes:

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- D. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.

3.02 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

3.03 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
 - 1. Excavate to the specified elevations.
 - 2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
 - 3. Cut utility trenches wide enough to allow inspection of installed utilities.
 - 4. Hand trim excavations. Remove loose matter.
- B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Preparation for Piling Work: Excavate to working elevations. Coordinate special requirements for piling.
- D. Do not interfere with 45 degree bearing splay of foundations.
- E. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard (0.25 cu m) measured by volume. See Section 312316.26 for removal of larger material.
- F. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 REPAIR

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.

SECTION 312316.13 TRENCHING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete.
- B. Section 310519 Geosynthetics for Earthwork.

1.02 REFERENCE STANDARDS

- A. AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2021, with Errata (2022).
- B. ASTM C136/C136M Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.
- C. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012 (Reapproved 2021).
- D. ASTM D1556/D1556M Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
- E. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)) 2012 (Reapproved 2021).
- F. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- G. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision (2020).
- H. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017a, with Editorial Revision (2021).

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Samples: 10 pound (4.5 kg) sample of each type of fill; submit in air-tight containers to testing laboratory.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Complying with State of Louisiana Department of Transportation standard.
- B. General Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.
 - 3. Complying with ASTM D2487 Group Symbol CL.
- C. Structural Fill: Complying with State of Lousiana Department of Transportation standard.
- D. Structural Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.
 - 3. Complying with ASTM D2487 Group Symbol CL.
- E. Concrete for Fill: Lean concrete.
- F. Concrete for Fill: See Section 033000; compressive strength of 2,500 psi (17.235 MPa).

- G. Granular Fill: Coarse aggregate, complying with State of Louisiana Department of Transportation standard.
- H. Granular Fill GravelPit run washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM D2487 Group Symbol GW.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2 inch (50 mm) sieve: 100 percent passing.
 - b. 1 inch (25 mm) sieve: 95 percent passing.
 - c. 3/4 inch (19 mm) sieve: 95 to 100 percent passing.
 - d. 5/8 inch (16 mm) sieve: 75 to 100 percent passing.
 - e. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - f. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - g. No. 16 (1.18 mm) sieve: 15 to 35 percent passing.
 - h. No. 40 (450 micro m): 10 to 25 percent passing.
 - i. No. 200 (75 micro m): 5 to 10 percent passing.
- I. Granular Fill Pea Gravel: Natural stone; washed, free of clay, shale, organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol GM.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. Minimum Size: 1/4 inch (6 mm).
 - b. Maximum Size: 5/8 inch (16 mm).
- J. Sand: Complying with Lafayette Public Works standards.
- K. Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol SW.
 - 2. Graded in accordance with ASTM C136/C136M; within the following limits:
 - a. No. 4 (4.75 mm) sieve: 100 percent passing.
 - b. No. 14 (1.40 mm) sieve: 10 to 100 percent passing.
 - c. No. 50 (300 micro m) sieve: 5 to 90 percent passing.
 - d. No. 100 (150 micro m) sieve: 4 to 30 percent passing.
 - e. No. 200 (75 micro m) sieve: 0 percent passing.
- L. Topsoil: See Section 312200.
- M. Topsoil: Complying with State Louisiana Department of Transportation standard.
- N. Topsoi: Topsoil excavated on-site.
 - 1. Graded.
 - 2. Free of roots, rocks larger than 1/2 inch (12 mm), subsoil, debris, large weeds and foreign matter.
 - 3. Acidity range (pH) of 5.5 to 7.5.
 - 4. Containing a minimum of 4 percent and a maximum of 25 percent inorganic matter.
 - 5. Complying with ASTM D2487 Group Symbol OH.

2.02 ACCESSORIES

- A. Geotextile: Non-biodegradable, woven.
- B. Geotextile: See Section 310519.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 TRENCHING

- A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet (1.2 meters) to angle of repose or less until shored.

- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
- G. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard (0.25 cu m) measured by volume. See Section 312316.26 for removal of larger material.
- H. Remove excavated material that is unsuitable for re-use from site.
- I. Remove excess excavated material from site.
- J. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- K. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Architect.

3.03 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.04 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches (150 mm) compacted depth.
- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. At 95 percent of maximum dry density.
 - 3. At other locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.

3.05 BEDDING AND FILL AT SPECIFIC LOCATIONS

3.06 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

SECTION 312316.26 ROCK REMOVAL

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. NFPA 495 - Explosive Materials Code 2018.

1.02 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate the proposed method of blasting, delay pattern, explosive types, type of blasting mat or cover, and intended rock removal method.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Explosives: Type recommended by explosive firm following seismic survey and required by authorities having jurisdiction.
- B. Delay Device: Type recommended by explosives firm.
- C. Blast Mat Materials: Type recommended by explosives firm.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting work of this section.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

3.03 ROCK REMOVAL

- A. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.
- B. Excavate and remove rock by either mechanical or explosive methods.
- C. Mechanical Methods: Drill holes and utilize expansive tools to fracture rock.
- D. If rock is uncovered requiring the explosives method for rock disintegration, notify the Architect.
- E. If rock is uncovered requiring the explosives method for rock disintegration, execute as follows:
 - 1. Provide seismographic monitoring during progress of blasting operations.
 - 2. Drill blasting holes within 12 feet (4 m) of finished slope.
 - 3. Disintegrate rock and remove from excavation.
- F. Use of Explosives: Obtain permits from authorities having jurisdiction before explosives are brought to site or drilling is started.
 - 1. Comply with NFPA 495 and applicable state and local codes.
 - 2. Prior to blasting, obtain a seismographic survey to determine maximum charges that can be used at each location in area of excavation without damaging adjacent properties or other work.
 - 3. Prior to executing seismographic survey, advise owners of adjacent buildings and structures in writing; explain planned survey and blasting operations.
 - 4. Prior to blasting, document conditions of buildings near locations of intended blasting and photograph existing conditions identifying existing irregularities.
 - 5. Schedule work to avoid working hours of occupied buildings nearby.
- G. Form level bearing at bottom of excavations.
- H. Remove shaled layers to provide sound and unshattered base for footings.
- I. In utility trenches, excavate to 6 inches (150 mm) below invert elevation of pipe and 24 inches (600 mm) wider than pipe diameter.
- J. Remove excavated materials from site.

K. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 312323.

3.04 FIELD QUALITY CONTROL

A. Independent agency field inspection will be provided under provisions of Section 014000 - Quality Requirements.

SECTION 312323 FILL

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete.
- B. Section 310519 Geosynthetics for Earthwork.
- C. Section 312323.43 Geofoam: Rigid, lightweight foam plastic fill.

1.02 REFERENCE STANDARDS

- A. AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2021, with Errata (2022).
- B. ASTM C136/C136M Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.
- C. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012 (Reapproved 2021).
- D. ASTM D1556/D1556M Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
- E. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)) 2012 (Reapproved 2021).
- F. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- G. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision (2020).
- H. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017a, with Editorial Revision (2021).

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data for Manufactured Fill.
- C. Shop Drawings for Manufactured Fill.
 - 1. Submit plan, section, and profile drawings. Indicate size, type, location, and orientation of each geofoam block.
 - 2. Submit location and type of connectors.
 - 3. Indicate proposed weighting or guying.
- D. Soil Samples: 10 pounds (4.5 kg) sample of each type of fill; submit in air-tight containers to testing laboratory.
- E. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.
- F. Compaction Density Test Reports.
- G. Lightweight Concrete Test Reports.
- H. Designer's Qualification Statement.
- I. Manufacturer's Qualification Statement.
- J. Lightweight Concrete Fill Installer's Qualification Statement.
- K. Testing Agency Qualification Statement.
- L. Specimen Warranty.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Perform design of structural fill under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Louisiana.

B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.05 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide ten year manufacturer warranty for manufactured fill material.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Complying with State of Louisiana Department of Transportation standard.
- B. General Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.
 - 3. Complying with ASTM D2487 Group Symbol CL.
- C. Structural Fill: Complying with State of Louisiana Department of Transportation standard.standard.
- D. Structural Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.
 - 3. Complying with ASTM D2487 Group Symbol CL.
- E. Concrete for Fill: Lean concrete.
- F. Concrete for Fill: See Section 033000; compressive strength of 2,500 psi (17.235 MPa).
- G. Granular Fill: Coarse aggregate, complying with State Louisiana Department of Transportation standard.standard.
- H. Granular Fill Gravel: Pit run washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM D2487 Group Symbol GW.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2 inch (50 mm) sieve: 100 percent passing.
 - b. 1 inch (25 mm) sieve: 95 percent passing.
 - c. 3/4 inch (19 mm) sieve: 95 to 100 percent passing.
 - d. 5/8 inch (16 mm) sieve: 75 to 100 percent passing.
 - e. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - f. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - g. No. 16 (1.18 mm) sieve: 15 to 35 percent passing.
 - h. No. 40 (450 micro m): 10 to 25 percent passing.
 - i. No. 200 (75 micro m): 5 to 10 percent passing.
- I. Granular Fill Pea Gravel: Natural stone; washed, free of clay, shale, organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol GM.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. Minimum Size: 1/4 inch (6 mm).
 - b. Maximum Size: 5/8 inch (16 mm).
- J. Sand: Complying with State Louisiana Department of Transportation standard.standard.
- K. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol SW.
 - 2. Graded in accordance with ASTM C136/C136M; within the following limits:
 - a. No. 4 (4.75 mm) sieve: 100 percent passing.
 - b. No. 14 (1.40 mm) sieve: 10 to 100 percent passing.

- c. No. 50 (300 micro m) sieve: 5 to 90 percent passing.
- d. No. 100 (150 micro m) sieve: 4 to 30 percent passing.
- e. No. 200 (75 micro m) sieve: 0 percent passing.
- L. Topsoil: Complying with State of Louisiana Department of Transportation standard. standard.
- M. Topsoil: Topsoil excavated on-site.
 - 1. Select.
 - 2. Graded.
 - 3. Free of roots, rocks larger than 1/2 inch (12 mm), subsoil, debris, large weeds and foreign matter.
 - 4. Acidity range (pH) of 5.5 to 7.5.
 - 5. Containing a minimum of 4 percent and a maximum of 25 percent inorganic matter.
 - 6. Complying with ASTM D2487 Group Symbol OH.
- N. Manufactured Fill Geofoam: Rigid foam plastic blocks.
 - 1. Material: Expanded polystyrene (EPS), clearly marked with manufacturer name and product type.
- O. Manufactured Fill Geofoam: See Section 312323.43.

2.02 ACCESSORIES

- A. Geotextile: Non-biodegradable, woven.
- B. Geotextile: See Section 310519.
- C. Vapor Retarder: 10 mil (0.25 mm) thick, polyethylene.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 6 inches (150 mm) to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches (150 mm) compacted depth.
- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:

- 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
- 2. At 95 percent of maximum dry density.
- 3. At other locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.
- L. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 ENGINEERED FILL - LIGHTWEIGHT CONCRETE

- A. Install lightweight concrete fill according to manufacturer's written instructions.
- B. Use batching, mixing, and placing equipment approved by the manufacturer.
- C. Prevent segregation of material.
- D. Tolerance: Finished surface within 2 inches (50 mm) of elevation indicated on drawings.

3.05 MANUFACTURED FILL INSTALLATION - GEOFOAM

- A. Provide finish grade free of holes and protrusions.
- B. Install 8 inch (200 mm) leveling pad of granular, permeable material approved by Architect.
- C. Place geofoam fill as indicated on drawings.
- D. Cut blocks with hot wire. Cutting with hand tools, with power tools, or by breaking block material is not permitted.
- E. Offset each layer of blocks 2 feet (610 mm) from adjacent rows.
- F. Rotate each layer of blocks 90 degrees (1.6 r) in the horizontal plane relative to previous layer.
- G. Connectors and Adhesive:
 - 1. Install connectors and adhesive as directed in geofoam manufacturer's written instructions.
 - 2. When mechanical connectors are used, install a minimum of two (2) connectors for each 4 feet by 8 feet (1.22 m by 2.44 m) section of material.
- H. Connectors and Adhesive: Install as indicated on shop drawings.
- I. Connectors and Adhesive: Install as directed by Architect.
- J. Provide temporary weighing and guying required to protect geofoam material until soil cover or pavement is in place.
- K. Avoid damage to geofoam material during other construction activities. Replace or repair damaged geofoam.

3.06 FILL AT SPECIFIC LOCATIONS

3.07 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for general requirements for field inspection and testing.
- B. Soil Fill Materials:
 - 1. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
 - 2. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.
 - 3. If tests indicate work does not meet specified requirements, remove work, replace and retest.

SECTION 312500 EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 312323 Fill: Filling and compaction.
- B. Section 329219 Seeding: Permanent turf for erosion control.

1.02 REFERENCE STANDARDS

- A. ASTM D5338 Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions, Incorporating Thermophilic Temperatures 2015 (Reapproved 2021).
- B. ASTM D7367 Standard Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting 2019, with Editorial Revision.
- C. ASTM D8298/D8298M Standard Test Method for Determination of Erosion Control Products (ECP) Performance in Protecting Slopes from Continuous Rainfall-Induced Erosion Using a Tilted Bed Slope 2020.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Sustainable Design Documentation: Submit documentation required in this section in accordance with requirements specified in Section 013329.02.
- C. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 2 PRODUCTS

2.01 MATERIALS

- A. High Performance Flexible Growth Medium (HP-FGM):
 - 1. Physical Properties:
 - a. Water Holding Capacity: Greater than or equal to 1,700 percent when tested in accordance with ASTM D7367.
 - b. Material Color: Green.
 - c. Cure Time: Zero to 2 hours.
 - d. Functional Longevity: Less than or equal to 18 months when tested in accordance with ASTM D5338.
 - e. Cover Factor: Less than or equal to 0.01 when tested in accordance with ASTM D8298/D8298M.
 - f. Application Rate: 3,500 lb per acre (3900 kg per hectare).
- B. Bonded Fiber Matrix (BFM):
 - 1. Physical Properties:
 - a. Water Holding Capacity: Greater than or equal to 1,200 percent when tested in accordance with ASTM D7367.
 - b. Material Color: Green.
 - c. Cure Time: 4 to 24 hours.
 - d. Functional Longevity: Observed, less than or equal to 6 months.
 - e. Cover Factor: Less than or equal to 0.05 when tested in accordance with ASTM D8298/D8298M.
 - f. Application Rate: 3,500 lb per acre (3900 kg per hectare).
- C. Engineered Fiber Matrix (EFM):
 - 1. Physical Properties:
 - a. Water Holding Capacity: Greater than or equal to 1,400 percent when tested in accordance with ASTM D7367.
 - b. Material Color: Green.

- c. Cure Time: 4 to 24 hours.
- d. Functional Longevity: Less than or equal to 12 months when tested in accordance with ASTM D5338.
- e. Cover Factor: Less than or equal to 0.05 when tested in accordance with ASTM D8298/D8298M.
- f. Application Rate: 3,500 lb per acre (3900 kg per hectare).
- D. Biotic Erosion Control Matrix (BECM):
 - 1. Physical Properties:
 - a. Water Holding Capacity: Greater than or equal to 850 percent when tested in accordance with ASTM D7367.
 - b. Material Color: Brown.
 - c. Cure Time: 12 to 24 hours.
 - d. Functional Longevity: Less than or equal to 12 months when tested in accordance with ASTM D5338.
 - e. Cover Factor: Less than or equal to 0.05 when tested in accordance with ASTM D8298/D8298M.
 - f. Application Rate: 6,500 lb per acre (7290 kg per hectare).

2.02 ACCESSORY MATERIALS

- A. Fill Material: See Section 312323.
- B. Fill Material: Soil, concrete, granular fill, sand, crushed stone, or waste materials used to raise an existing grade, acceptable to authorities having jurisdiction, and in compliance with specified performance requirements.
- C. Mulching Material: See Section 329219.
- D. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 FIELD QUALITY CONTROL

3.04 MAINTENANCE

- A. Provide maintenance of seeded areas for three months from Date of Substantial Completion.
- B. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- C. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (13 mm) or more rainfall at the project site, and daily during prolonged rainfall.
- D. Repair deficiencies immediately.

3.05 CLEAN UP

A. Clean out sediment control structures that are to remain as permanent measures.

SECTION 313116 TERMITE CONTROL

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

1.02 REFERENCE STANDARDS

- A. ASTM E1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs 2018a.
- B. ASTM E1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs 2017.
- C. Title 7, United States Code, 136 through 136y Federal Insecticide, Fungicide and Rodenticide Act 2019.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.
- C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements.
- D. Test Reports: Indicate regulatory agency approval reports when required.
- E. Test Reports: Submit termite-resistant sheet manufacturer's summary of independent laboratory and field testing for effectiveness in subterranean termite exclusion.
- F. Warranty: Submit warranty and ensure that forms have been completed in Owner's name.

1.04 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide five year installer's warranty against damage to building caused by termites.
 - 1. Include coverage for repairs to building and to contents damaged due to building damage. Repair damage and, if required, re-treat.
 - 2. Inspect annually and report in writing to Owner.
- C. Termite-Resistant Vapor Barrier Sheet: Provide five year manufacturer's limited warranty.

PART 2 PRODUCTS

2.01 CHEMICAL SOIL TREATMENT

- A. Toxicant Chemical: EPA Title 7, United States Code, 136 through 136y approved; synthetically color dyed to permit visual identification of treated soil.
- B. Diluent: Recommended by toxicant manufacturer.
- C. Mixes: Mix toxicant to manufacturer's instructions.

2.02 SITE-APPLIED TERMITICIDE

- A. Site Applied Termiticide for Wood, Steel and Concrete: Borate mineral salt based, spray applied termiticide formulated for use on wood, steel, concrete and other building materials.
 - 1. Active Ingredient: 40% minimum disodium octaborate tetrahydrate (DOT).
 - 2. Carrier and Penetrant: Proprietary glycol solution.

2.03 TERMITE BARRIER SHEET

- A. Termite-Resistant Vapor Barrier Sheet: Plastic sheet, complying with ASTM E1745, Class C; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs, and for exclusion of subterranean termites.
- B. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.

PART 3 EXECUTION

3.01 APPLICATION - CHEMICAL TREATMENT

- A. Comply with requirements of U.S. EPA and applicable state and local codes.
- B. Spray apply toxicant in accordance with manufacturer's instructions.
- C. Apply toxicant at following locations:
 - 1. Under Slabs-on-Grade.
 - 2. In Crawl Spaces.
 - 3. At Both Sides of Foundation Surface.
 - 4. Soil Within 10 feet (3 m) of Building Perimeter
- D. Under slabs, apply toxicant immediately prior to installation of vapor barrier.
- E. At foundation walls, apply toxicant immediately prior to finish grading work outside foundations.
- F. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.
- G. Re-treat disturbed treated soil with same toxicant as original treatment.
- H. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.02 INSTALLATION - SITE-APPLIED TERMITICIDE

3.03 INSTALLATION - BARRIER SHEET

- A. Comply with ASTM E1643.
- B. Lap joints minimum 6 inches (150 mm). Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.

SECTION 313213.16 CEMENT SOIL STABILIZATION

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 310519 Geosynthetics for Earthwork.
- B. Section 312316 Excavation: General site and building excavation.
- C. Section 312316.26 Rock Removal.
- D. Section 312323 Fill: Soil and aggregate materials.

1.02 REFERENCE STANDARDS

- A. ASTM C150/C150M Standard Specification for Portland Cement 2022.
- B. ASTM D558 Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures 2011.
- C. ASTM D1556/D1556M Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
- D. ASTM D1633 Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders 2017.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Submit mix design and materials mix ratio that will achieve specified requirements.
- C. Test reports on compressive strength of mix.
- D. Samples: Submit 10 lb (4.5 kg) sample of each type of fill in air-tight containers, to testing laboratory.

1.04 FIELD CONDITIONS

A. Do not install mixed materials in wind in excess of 10 mph (16 k/h) or when temperature is below 40 degrees F (5 degrees C).

PART 2 PRODUCTS

2.01 MIX MATERIALS

- A. Coarse Aggregate: Granular fill, see Section 312323.
- B. Fine Aggregate: Sand fill, see Section 312323.
- C. Subsoil: General fill, see Section 312323.
- D. Subsoil: Existing reused.
- E. Cement: ASTM C150/C150M, Portland cement, Type I, Normal.

2.02 EQUIPMENT

A. Equipment: Capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting material.

2.03 SOIL CEMENT MIX

- A. Mix materials in accordance with Louisiana Department of Transportation standards.
- B. Mix subsoil, cement, and aggregate.1. Quantity of cement is not to exceed 10 percent of dry mixed materials by volume.
- C. Mix to obtain a minimum compressive strength of 450 psi (3 MPa) at 7 days.
 1. Test mix for compressive strength in accordance with ASTM D1633.
- D. Add water to the mix to achieve a homogeneous damp mixture without lumping, yet not creating a wet plastic consistency.
- E. Obtain approval of the mix before proceeding with placement.

2.04 ACCESSORIES

- A. Curing Seal: Asphalt emulsion primer.
- B. Geotextile: Nonwoven polypropylene.
- C. Geotextile: See Section 310519.

PART 3 EXECUTION

3.01 EXCAVATION

- A. Protect adjacent structures from damage by this work.
- B. Excavate subsoil to depth indicated.
- C. Excavate subsoil to depth sufficient to accommodate soil stabilization, construction operations, and other materials.
- D. Proof roll subgrade to identify soft areas; excavate those areas.
- E. Do not excavate within normal 45 degree bearing splay of any foundation.
- F. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd (0.25 cu m) measured by volume. Larger material will be removed under Section 312316.26.
- G. Notify Architect of unexpected subsurface conditions. Discontinue affected Work in area until notified to resume work.
- H. Correct areas over-excavated in accordance with Section 312316.
- I. Stockpile excavated material in area designated on site; remove excess material not being reused from site.
- J. Remove excess excavated material from site.

3.02 SOIL TREATMENT AND BACKFILLING

- A. Place geotextile over subsoil surface, lap edges and ends.
- B. Site mix subsoil, backfill and compact. Blend treated subsoil mix to achieve mix formulation and required stabilization.
- C. Place mix material in continuous layers not exceeding 8 inches (200 mm) depth.
- D. Maintain optimum moisture content of mix materials to attain required stabilization. If more than one layer, maintain lower layer at optimum moisture until next layer is placed.
- E. Place mixed materials within 2.5 hours of adding water to mix.
- F. Do not exceed 30 minutes in placing adjacent mixed material.
- G. Commence compaction of mix no later than 60 minutes after placement.
- H. Compact mix to minimum of 97 percent of maximum density determined in accordance with ASTM D558; test in-place density in accordance with ASTM D1556/D1556M.
- I. Slope grade away from building minimum 2 inches in 10 ft (51 mm in 3 m), unless noted otherwise.
- J. Shape to required line, grade, and cross section.
- K. Make grade changes gradual. Blend slopes into level areas.
- L. At end of day, terminate completed Work by forming a straight and vertical construction joint.
- M. Replace damaged fill with new mix to full depth of original mix.
- N. Remove surplus mix materials from site.

3.03 FIELD QUALITY CONTROL

A. Compression test and analysis of hardened fill material will be performed in accordance with ASTM D1633.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

SECTION 313213.19 LIME SOIL STABILIZATION

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 310519 Geosynthetics for Earthwork.
- B. Section 312316 Excavation: General site and building excavation.
- C. Section 312323 Fill: Soil and aggregate materials.

1.02 REFERENCE STANDARDS

- A. AASHTO M 216 Standard Specification for Quicklime and Hydrated Lime for Soil Stabilization 2022.
- B. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012 (Reapproved 2021).
- C. ASTM D1556/D1556M Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
- D. NLA Bull 326 Lime-Treated Soil Construction Manual: Lime Stabilization & Lime Modification 2004.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Submit mix design and materials mix ratio that will achieve specified requirements.
- C. Samples: Submit 10 lb (4.5 kg) sample of each type of fill in air-tight containers, to testing laboratory.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with NLA Bull 326.
- B. Perform Work in accordance with Louisiana Department of Transportation standards.

PART 2 PRODUCTS

2.01 MIX MATERIALS

- A. Coarse Aggregate: Granular fill specified in Section 312323.
- B. Fine Aggregate: Sand fill specified in Section 312323.
- C. Subsoil: General fill specified in Section 312323.
- D. Subsoil: Existing reused.
- E. Lime: AASHTO M 216 hydrated lime.

2.02 EQUIPMENT

A. Equipment: Capable of excavating subsoil, mixing and placing materials, wetting, consolidation, and compaction of material.

2.03 LIME/SOIL MIX

- A. Mix materials in accordance with Louisiana Department of Transportation standards.
- B. Mix subsoil, lime, sand and aggregate. Quantity of lime is not to exceed 10 percent of dry mixed materials by volume.

2.04 ACCESSORIES

- A. Curing Seal: Asphalt emulsion primer.
- B. Geotextile: Nonwoven polypropylene.
- C. Geotextile: See Section 310519.

PART 3 EXECUTION

3.01 EXCAVATION

- A. Protect adjacent structures from damage by this work.
- B. Excavate subsoil to depth indicated.
- C. Proof roll subgrade to identify soft areas; excavate those areas.
- D. Do not excavate within normal 45 degree bearing splay of any foundation.
- E. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd (0.25 cu m) measured by volume. Larger material will be removed under Section 312316.26.
- F. Notify Architect of unexpected subsurface conditions. Discontinue affected Work in area until notified to resume work.
- G. Correct areas over-excavated in accordance with Section 312316.
- H. Stockpile excavated material in area designated on site; remove excess material not being reused from site.
- I. Remove excess excavated material from site.

3.02 SOIL TREATMENT AND BACKFILLING

- A. Place geotextile over subsoil surface, lap edges and ends.
- B. Site mix subsoil, backfill and compact. Blend treated subsoil mix to achieve mix formulation and required stabilization.
- C. Mix and wait 16 hours minimum and no more than 72 hours maximum before placing.
- D. Place mix material in continuous layers not exceeding 12 inches (300 mm) depth.
- E. Maintain optimum moisture content of mix materials to attain required stabilization.
- F. Do not exceed 30 minutes in placing adjacent mixed material.
- G. Commence compaction of mix no later than 60 minutes after placement.
- H. Compact to 95 percent of maximum density determined in accordance with ASTM D698; test in-place density in accordance with ASTM D1556/D1556M.
- I. Slope grade away from building minimum 2 inches in 10 ft (150 mm in 3 m), unless noted otherwise.
- J. Shape to required line, grade, and cross section.
- K. Make grade changes gradual. Blend slope into level areas.
- L. At end of day, terminate completed Work by forming a straight and vertical construction joint.
- M. Replace damaged fill with new mix to full depth of original mix.
- N. Remove surplus mix materials from site.

3.03 FIELD QUALITY CONTROL

- A. Compression test and analysis of hardened fill material will be performed in accordance with ASTM D698.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

SECTION 313700 RIPRAP

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 310519 Geosynthetics for Earthwork.
- B. Section 312323 Fill: Aggregate requirements.

1.02 QUALITY ASSURANCE

A. Perform Work in accordance with Louisiana Department of Transportation standards.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Riprap: Provide in accordance with Louisiana Department of Transportation standards.
- B. Riprap: Granite type; broken stone; solid and nonfriable; 6 inch (150 mm) minimum size, 12 inch (300 mm) maximum size.
- C. Riprap: Broken stone, 6 inch (150 mm) minimum size, 12 inch (300 mm) maximum size; solid and nonfriable.
- D. Aggregate: Granular fill, see Section 312323.
- E. Bags: Woven jute.
- F. Binder: Portland cement.
- G. Geotextile: Non-biodegradable, woven.
- H. Geotextile: See Section 310519.

2.02 BAGGED RIPRAP

- A. Mix riprap, cement, sand and aggregate dry. Limit quantity of cement to 10 percent of dry mixed materials by volume.
- B. Fill bags with dry ingredients to 70 percent capacity and close by sewing or stapling to a straight seam.

PART 3 EXECUTION

3.01 PLACEMENT

- A. Place geotextile over substrate, lap edges and ends.
- B. Place riprap at culvert pipe ends, embankment slopes, and as indicated.
- C. Place bags into position. Knead, ram, or pack filled bags to fit with the contour of adjacent material and other bags previously placed.
- D. Place bags in a staggered pattern. Remove foreign matter from bag surfaces.
- E. Installed Thickness: 5 inch (125 mm) average.
- F. After placement, spray with water to moisten the bagged mix. Maintain moist for 24 hours.

SECTION 320116.74 IN PLACE HOT REUSED ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. AI MS-19 - Basic Asphalt Emulsion Manual 2008.

1.02 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on asphalt rejuvenating agent.
- C. Mix Design: Submit mix design proposed.

1.03 QUALITY ASSURANCE

- A. Perform Work in accordance with the LADOTD 2016 Standard Specifications for Roads and Bridges.
- B. Perform Work in accordance with AI MS-20.
- C. Maintain one copy of each document on site.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Recycled Material: Existing in-place asphaltic concrete.
- B. Virgin Mix Materials: Provide in accordance with LADOTD 2016 Standard Specifications for Roads and Bridges
- C. Seal Coat: AI MS-19; sand type.

2.02 EQUIPMENT

- A. Recycling Equipment: Type for the intended purpose as follows:
 - 1. Self-propelled, with automated mix controls.
- B. Heated Asphalt Remixer: Type for the intended purpose as follows:
 - 1. Self-propelled, with a wheel base sufficient to maximize leveling action.
 - 2. Capable of processing 5,500 sq yd (4,645 sq m) of surface per day.
- C. Milling Unit: Type for the intended purpose as follows:
 - 1. Self-propelled, with a wheel base sufficient to maximize leveling action.
 - 2. Capable of loosening pavement material to a 2 inch (50 mm) depth.
- D. Onboard Pug Mill: Type for the intended purpose as follows:
 - 1. Horizontal shaft, hydrostatically driven, heated mixer.
 - 2. Capable of adding and remixing recycled material, rejuvenating agent, and virgin mat.
 - 3. To produce uniform mixture at required temperature.
- E. Compactor: Pneumatic tired roller for initial compaction; steel wheeled rollers required for additional compaction and smoothness. An oscillating screed or tamper is not acceptable.

2.03 RECYCLED MIX

- A. Remove random samples of existing pavement material; record sample location and perform testing.
- B. Establish mix design from test sample materials.
- C. Identify asphalt content, aggregate gradation curve, penetration value, viscosity of residual asphalt, and density.
- D. Establish recycling agent demand ratios; determine maximum stability curve to support demand ratios.
- E. Maintain minimum moisture content of 3 percent.

PART 3 EXECUTION

3.01 REMOVAL

- A. Heat pavement surface uniformly by continuous movement of a heated scarifier.
- B. Execute removal to a depth not less than 1/2 inch (12 mm) at any point across the full width of surface without detrimental aggregate degradation.

3.02 MIXING

- A. Mix removed material by spinning or tumbling action for asphalt rejuvenation.
- B. Blend recycled material, recycling agent, and virgin material in pug mill in accordance with Asphalt Recycling and Reclaiming Association' ARRA ARS-5-HR, Proven Guidelines for Hot-Mix Recycling.
- C. Blend recycled material, recycling agent and virgin material in pug mill in accordance with LADOTD 2016 Standard Specifications for Roads and Bridges

3.03 PLACING

- A. Discharge remixed material and added virgin material by a heated vibratory precompactor.
- B. Spread material in a windrow for profiling and precompaction.
- C. Compact by a heated vibratory screed to a uniform cross sectional thickness.

3.04 ROLLING AND COMPACTING

A. Roll and compact pavement materials to elevations existing before commencing the Work.

3.05 SEAL COAT

A. Apply seal coat to top surface of wearing course in accordance with Asphalt Institute MS-19.

SECTION 320120 PREPARATION FOR RESURFACING CONCRETE PAVEMENTS

PART 2 PRODUCTS

PART 3 EXECUTION

2.01 CLEANING

- A. Clean concrete surfaces of dirt or other contamination; wire brush using water; rinse surface and allow to dry.
- B. Flush out cracks and voids with cleaning agent to remove laitance and dirt. Chemically neutralize by rinsing with water.
- C. Blast clean clean the exposed concrete surfaces.

SECTION 320190 OPERATION AND MAINTENANCE OF PLANTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Maintain plants in manner that promotes health, growth, color and appearance, to quality levels specified; replace dead, dying, and damaged plants at no extra cost to Owner.
 - 1. It is Contractor's responsibility to determine type and quantity of soil amendments and fertilizer required.
- B. Operate permanent irrigation system.
- C. Clean up landscaped areas.
- D. Maintenance Period: The time frame covered by these requirements is 90 days:

1.02 RELATED REQUIREMENTS

- A. Section 329219 Seeding.
- B. Section 329300 Plants.

1.03 REFERENCE STANDARDS

- A. ANSI A300 Part 1 American National Standard for Tree Care Operations Tree, Shrub, and Other Woody Plant Management Standard Practices (Pruning) 2017.
- B. ANSI Z133.1 American National Standard for Arboricultural Operations Safety Requirements 2017.
- C. ASTM C602 Standard Specification for Agricultural Liming Materials 2020.
- D. ASTM D4972 Standard Test Methods for pH of Soils 2019.
- E. ASTM D5883 Standard Guide for Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes 2018.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Soil Tests and Analysis: Submit report showing number of samples, test results, and recommendations for soil amendments and fertilizer.
- C. Product Data: Manufacturer's data sheets on each fertilizer, herbicide, pesticide, and other chemical material to be used, showing trade name, chemical composition, mixing instructions, recommended application rate, storage and handling instructions, and application instructions.
- D. Shop Drawings:
 - 1. Maintenance plan.
 - 2. Recommendations of the local Cooperative Extension Service office for maintenance and care of turf.

PART 2 PRODUCTS

2.01 FERTILIZERS AND SOIL AMENDMENTS

- A. Fertilizers: Free flowing granular organic type containing nitrogen, phosphorus, and potassium, plus trace minerals and micro-nutrients; controlled release type is preferred.
 - 1. Determine type and quantity based on soil analysis.
 - 2. Turf Fertilizer: As specified in Section 329219.
 - 3. Turf Fertilizer:
 - 4. Non-Turf Plant Fertilizer: As specified in Section 329300.
 - 5. Non-Turf Plant Fertilizer:
- B. Soil Amendments: Type and quantity as required to achieve specified results, based on soil analysis.
- C. pH Adjuster: ASTM C602 Class O limestone.

- D. Gypsum: Commercially packaged, free flowing, minimum 95 percent calcium sulfate by volume.
- E. Sand: Clean and free of materials harmful to plants; 95 percent by weight, minimum, passing No.10 ((2 mm) sieve and 10 percent by weight, minimum, passing No.16 ((1.18 mm) sieve.
- F. Calcined Clay: Granular particles produced from montmorillonite clay calcined to minimum temperature of 1200 degrees F (650 degrees C).
- G. Expanded Shale, Clay, or Slate: ASTM D5883, rotary kiln produced.
- H. Decomposed Wood Derivatives: Ground bark, sawdust, humus or other green wood waste material; free of stones, sticks, and fully composted or stabilized with nitrogen.
- I. Recycled Compost: Well decomposed, stable, weed free; derived from food, agricultural or industrial residuals, biosolids, yard trimmings, or source-separated or mixed solid waste; with no objectionable odors and not resembling the raw material from which it was made; no substances toxic to plants.
- J. Worm Castings: Commercially packaged, without worms or food source.
- K. Manure: Unleached horse, chicken, or cattle manure, well rotted, containing maximum 25 percent by volume of straw, sawdust, and other bedding materials and no chemicals or ingredients harmful to plants; heat treated to kill weed seeds.
- L. Bonemeal: Finely ground, steamed, with 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

2.02 APPLIED MATERIALS

- A. Antidessicants: Sprayable, water insoluble film-forming material that produces a moisture retarding barrier not removable by rain or snow.
- B. Plant Growth Regulators: Sprayable, foliar absorbed non-translocatable liquid; not for application via permanent irrigation system.
- C. Organic Mulch: Maintain general appearance of existing mulched areas; use one of the following types:
 - 1. Wood chips ranging in size from 1/2 inch (12 mm) to one inch (25 mm).
 - 2. Ground or shredded bark.
 - 3. Shredded hardwood ranging in size from 1/2 inch (12 mm) to one inch (25 mm).
 - 4. Bark peelings ranging in size from 1/2 inch (12 mm) to one inch (25 mm).
 - 5. Pine straw.
 - 6. Marsh hay.
 - 7. Pine needles.
 - 8. Peanut, pecan, or cocoa bean shells.
 - 9. Recovered 100 percent paper-based materials ranging in size from 1/2 inch (12 mm) to one inch (25 mm).
 - 10. Recovered 100 percent wood-based materials ranging in size from 1/2 inch (12 mm) to one inch (25 mm).
- D. Inorganic Mulch: Match existing mulched areas.
- E. Pesticides: U.S. EPA registered.
- F. Herbicides for Use on Turf: U.S. EPA registered.
- G. Water: Suitable for irrigation; Owner's water supply may be used.

PART 3 EXECUTION

3.01 EXAMINATION

A. If soil analysis has not already been performed, take sufficient samples to obtain a comprehensive analysis; perform analysis in accordance with ASTM D4972.

3.02 LANDSCAPE MAINTENANCE - GENERAL

A. Obtain and follow the maintenance instructions provided by the installer of new plant materials.

- B. Protect existing vegetation, pavements, and facilities from damage due to maintenance activities; restore damaged items to original condition or replace, at no extra cost to Owner.
- C. General Cleanup: Remove debris from all landscape areas at least once a week and from turf areas before each mowing.
 - 1. Debris consists of trash, rubbish, dropped leaves, downed branches and limbs of all sizes, dead vegetation, rocks, and other material not belonging in landscaped areas.
 - 2. Remove debris from site and dispose of properly.
- D. Watering, Soil Erosion, and Sedimentation Control: Comply with federal, state, local, and other regulations in force; prevent over-watering, run-off, erosion, puddling, and ponding.
 - 1. Repair temporary erosion control mechanisms provided by others.
 - 2. Repair eroded areas and replant, when caused by inadequate maintenance.
 - 3. Prevent sediment from entering storm drains.
- E. Trees: Exercise care to avoid girdling trees; provide protective collars if necessary; remove protective collars at end of maintenance period.
- F. Fertilizing: Apply fertilizer only when necessary.
- G. Drainage Channels: Remove obstructions in gutters, catch basins, storm drain inlets, yard drains, swales, ditches, and overflows.
 - 1. Remove grates from catch basins to clean.
 - 2. Prevent encroachment of other vegetation on turfed surface drainage channels.
- H. Health Maintenance: Inspect all plants regularly for health:
 - 1. Eradicate diseases and damaging pests, regardless of severity or speed of effect.
 - 2. Treat accidental injuries and abrasions.
 - 3. If a plant is unhealthy but not yet dead, according to specified definitions, determine reason(s) and take remedial action immediately.
 - 4. Remove dead plants immediately upon determining that they are dead.
- I. Pesticide and Herbicide Application: Comply with manufacturer's instructions and recommendations and applicable regulations.
 - 1. Obtain Owner's approval prior to each application.
 - 2. Apply in manner to prevent injury to personnel and damage to property due to either direct spray or drifting, both on and off Owner's property.
 - 3. Use backflow preventers on hose bibbs used for mixing water; prevent spills.
 - 4. Inspect equipment daily before application; repair leaks, clogs, wear, and damage.
 - 5. Do not dispose of excess mixed material, unmixed material, containers, residue, rinse water, or contaminated articles on site; dispose of off site in legal manner.
 - 6. Rinse water may be used as mix water for next batch of same formulation.
 - 7. Contractor is responsible for all recordkeeping, submissions, and reports required by laws and regulations.
- J. Replanting: Perform replacement and replanting immediately upon removal of dead plant.

3.03 IRRIGATION

- A. Irrigation: Do not allow plants to wilt; apply water as required to supplement rainfall; do not waste water; do not water plants or areas not needing water; do not water during rainfall; shut off water flow when finished; repair leaks.
 - 1. New automatic irrigation system may be used.
 - 2. Provide backflow preventers on hose bibbs used for irrigation hoses.
- B. Automatic Irrigation System: Obtain and follow manufacturer's operating and maintenance instructions.
 - 1. Adjust to water landscape areas only.
 - 2. Adjust sprinkler heads, drippers, valves, pumps, and controllers as required for optimum operation.
 - 3. Drain and prepare for freezing weather; prepare and start up in spring.
4. During system warranty period notify Architect and system installer promptly of defects and leaks that adversely affect irrigation performance.

3.04 RENOVATION OF ESTABLISHED TURF

- A. Remove turf from around trees to radius of 18 inches (450 mm) from base of tree trunk. Cut turf out and remove; do not simply mow. Trim turf edge as specified.
- B. Trim perimeter of turf area and around intervening objects as specified under Turf Maintenance.
- C. Eliminate undesirable grasses and weeds. Remove as much thatch as possible.
- D. Aerate established turf at least once every two years by coring and pulling out soil plugs 2 to 3 inches (50 to 75 mm) deep and not more than 2 inches (50 mm) apart.
 - 1. Clean plugs from pavements immediately.
- E. Apply fertilizer over entire aerated area.
- F. After aeration, seed entire aerated area as specified in Section 329219; rake or brush seed into contact with soil.
- G. Water as soon as possible after planting. Do not allow newly planted material to become dry.
- H. Fertilize again 3 to 4 weeks after seeding.
- I. Begin normal mowing once grass reaches 1-1/2 times specified mowing height.

3.05 TURF MAINTENANCE

- A. Maintain turf in manner required to produce turf that is healthy, uniform in color and leaf texture, and free from weeds and other undesirable growth.
 - 1. Grass Density Lawns: 20 plants per square foot (200 plants per square meter), minimum.
 - 2. Bare Spots Lawns: 2 percent of total area, maximum; 6 inches (150 mm) square, maximum.
 - 3. Keep turf relatively free of thatch, woody plant roots, diseases, nematodes, soil-borne insects, stones larger than 1 inch (25 mm) in diameter, and other materials detrimental to grass growth.
 - 4. Limit broadleaf weeds and patches of foreign grass to a maximum of 2 percent of the total area.
- B. Mowing: During growing season(s) mow turf to uniform height, in manner that prevents scalping, rutting, bruising, and uneven or rough cutting.
 - 1. Prior to mowing clean all debris and leaves from turf surface.
 - 2. Schedule frequency of mowing so that no more than one-quarter to one-third of grass leaf length is removed during a cutting.
 - 3. Make each successive mowing at approximately 45 degrees to the previous mowing, if practical.
 - 4. Cool Season Grasses:
 - a. Reduce mowing height in fall and spring.
 - b. Use rotary type mowers; mulcher type mowers may be used.
 - 5. Warm Season Grasses:
 - a. Increase mowing height slightly as fall approaches.
 - b. Use reel type mowers; do not use mulcher mowers.
- C. Summer Mowing Height for Lawns:
- D. Trimming: Immediately after each mowing, neatly trim perimeter of each turf area and around obstructions within turf area; match height and appearance of adjacent turf.
 - 1. Adjacent to Pavements: Cut edges of turf to form a distinct, uniform turf edge.
 - 2. Adjacent to Planting Beds and Permanently Mulched Areas: Cut edges of turf to form a distinct, uniform turf edge.
 - 3. Around Other Trees and Poles: Where no planting bed or mulched area exists, trimming with string trimmer is acceptable.
 - 4. At Fences: Trim on both sides of fence.

- 5. Irrigation Heads and Valve Boxes: Trim neatly so grass doesn't interfere with operation.
- E. Fertilizer: Apply as recommended by manufacturer and at rate indicated by soil analysis.
 - 1. Cool Season Grasses: Apply at least once, in Fall before first frost; do not apply high nitrogen fertilizer during Summer; Spring application is optional but must be reduced in quantity.

3.06 PLANTING BED MAINTENANCE

- A. Planting beds include all planted areas except turf.
- B. Begin maintenance immediately after plants have been installed; inspect at least once a week and perform needed maintenance promptly.
- C. Keep planting beds free of pests; remove weeds and grass by hand before reaching 1 inch (25 mm) height.
- D. Do not allow climbing, twining, or creeping plants to encroach into other species.
- E. Replace mulch as required and remove debris.

3.07 TREE AND SHRUB MAINTENANCE

- A. Trees will be considered dead when main leader has died back or when 25 percent or more of crown has died ; except as otherwise indicated for palm trees.
- B. Shrubs will be considered dead when 25 percent or more of plant has died.
- C. Inspect woody plants for health by scraping up to 1/16 inch (2 mm) square area of bark; no green cambium layer below bark shall be evidence of death.
- D. Adjust stakes, guys and turnbuckles, ties, and trunk wrap as required to promote growth and avoid girdling.
- E. Fertilizing: Fertilize all trees at least once during maintenance period, preferably in the Fall; use accepted standards for determining type and method of fertilization.
- F. Pruning: Unless otherwise indicated, prune only to maintain balanced natural shape; follow recommendations of ANSI A300 and ANSI Z133.1 and best local practices for species involved.
- G. Shrubs: Prune at least once during maintenance period at best time to influence ultimate shape and size for the particular species.
 - 1. Prune to balance the plant's form and according to its natural growth characteristics.
 - 2. Remove water shoots, suckers, and branches not complying with desired shape and size.
- H. Hedges: Trim to encourage growth into voids and gaps.

3.08 CLEANING

- A. Remove fallen deciduous leaves in Fall; removal may wait until all leaves have fallen.
- B. Clean adjacent pavements of plant debris and other debris generated by maintenance activities.
- C. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner; Owner's trash collection facilities may be used.
- D. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner.
 - 1. Biodegradable Debris: Owner will designate a compost pile on site where biodegradable debris may be deposited; branches and bark are not considered biodegradable.
 - 2. Branches and Bark: Owner will designate a wood chip storage area; machine-chip all branch and bark debris.
 - 3. Non-Biodegradable Debris: Owner's trash collection facilities may be used.

SECTION 321123 AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 310519 - Geosynthetics for Earthwork.

1.02 REFERENCE STANDARDS

- A. AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2021, with Errata (2022).
- B. ASTM C136/C136M Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.
- C. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012 (Reapproved 2021).
- D. ASTM D1556/D1556M Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
- E. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)) 2012 (Reapproved 2021).
- F. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- G. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision (2020).
- H. ASTM D6693/D6693M Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes 2020.
- I. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017a, with Editorial Revision (2021).

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Samples: 10 lb (4.5 kg) sample of each type of aggregate; submit in air-tight containers to testing laboratory.
- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Coarse Aggregate: Coarse aggregate, complying with LADOTD 2016 Standard Specifications for Roads and Bridgess.
- B. Coarse Aggregate: Natural washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM D2487 Group Symbol GW.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2 inch (50 mm) sieve: 100 percent passing.
 - b. 1 inch (25 mm) sieve: 95 percent passing.
 - c. 3/4 inch (19 mm) sieve: 95 to 100 percent passing.
 - d. 5/8 inch (16 mm) sieve: 75 to 100 percent passing.
 - e. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - f. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - g. No. 16 (1.18 mm) sieve: 15 to 35 percent passing.
 - h. No. 40 (450 micro m): 10 to 25 percent passing.
 - i. No. 200 (75 micro m): 5 to 10 percent passing.
- C. Blended Aggregate: stone; free of shale, clay, friable material and debris.
 - . Graded in accordance with ASTM D2487 Group Symbol GW.

- D. Medium Aggregate: Natural stone; pea gravel, washed, free of clay, shale, organic matter.
 1. Grade in accordance with ASTM D2487 Group Symbol GM.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. Minimum Size: 1/4 inch (6 mm).
 - b. Maximum Size: 5/8 inch (16 mm).
- E. Fine Aggregate: Sand; complying with LADOTD 2016 Standard Specifications for Roads and Bridges
- F. Fine Aggregate: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol SW.
 - 2. Graded in accordance with ASTM C136/C136M; within the following limits:
 - a. No. 4 (4.75 mm) sieve: 100 percent passing.
 - b. No. 14 (1.40 mm) sieve: 10 to 100 percent passing.
 - c. No. 50 (300 micro m) sieve: 5 to 90 percent passing.
 - d. No. 100 (150 micro m) sieve: 4 to 30 percent passing.
 - e. No. 200 (75 micro m) sieve: 0 percent passing.
- G. Geotextile: Nonbiodegradable, woven.
- H. Geotextile: See Section 310519.
- I. Geocell Grid: High density polyethylene, perforated.
 - 1. Cell Depth: 3 inches (76 mm).
 - 2. Cell Area: 45 sq in (290 sq cm), nominal.
 - 3. Tensile Strength: 1,000 psf (16 018 ksm), minimum when tested in accordance with ASTM D6693/D6693M.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Under Bituminous Concrete Paving:
 - 1. Compact to 95 percent of maximum dry density.
- B. Under Portland Cement Concrete Paving:1. Compact to 95 percent of maximum dry density.
- C. Place aggregate in maximum 4 inch (100 mm) layers and roller compact to specified density.
- D. Level and contour surfaces to elevations and gradients indicated.
- E. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- F. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
- H. Install geocell grid in accordance with manufacturers instructions.

3.02 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").

SECTION 32121 ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Single course bituminous concrete paving.
- C. Double course bituminous concrete paving.
- D. Surface sealer.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. AASHTO M 147 Standard Specification for Materials for Aggregate and Soil–Aggregate Subbase, Base, and Surface Courses 2017 (Reapproved 2021).
- B. AI MS-2 Asphalt Mix Design Methods 2015.
- C. Al MS-19 Basic Asphalt Emulsion Manual 2008.
- D. ASTM C136/C136M Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.
- E. ASTM D946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction 2009a.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with LADOTD Standard Specifications for Roads and Bridges.
- B. Mixing Plant: Complying with LADOTD Standard Specifications for Roads and Bridges.
- C. Obtain materials from same source throughout.

1.05 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.
- B. Place bitumen mixture when temperature is not more than 15 F degrees (8 C degrees) below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with applicable code for paving work on public property.

2.02 MATERIALS

- A. Asphalt Cement: ASTM D946.
- B. Aggregate for Base Course: In accordance with LADOTD Standard Specifications for Roads and Bridges.
- C. Aggregate for Base Course: Angular crushed washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM D2487 Group Symbol GW.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2 inch (50 mm) sieve: 100 percent passing.
 - b. 1 inch (25 mm) sieve: 95 percent passing.
 - c. 3/4 inch (19 mm) sieve: 95 to 100 percent passing.
 - d. 5/8 inch (16 mm) sieve: 75 to 100 percent passing.
 - e. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - f. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - g. No. 16 (1.18 mm) sieve: 15 to 35 percent passing.

- i. No. 200 (75 micro m): 5 to 10 percent passing.
- D. Aggregate for Binder Course: In accordance with LADOTD Standard Specifications for Roads and Bridges.
- E. Aggregate for Binder Course: AASHTO M 147, Grade; passing the sieve with a liquid limit of not more than 25; a plasticity index of not more than 5 in accordance with ASTM D4318.
- F. Aggregate for Binder Course: Angular crushed washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM D2487 Group Symbol GW.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2 inch (50 mm) sieve: 100 percent passing.
 - b. 1 inch (25 mm) sieve: 95 percent passing.
 - c. 3/4 inch (19 mm) sieve: 95 to 100 percent passing.
 - d. 5/8 inch (16 mm) sieve: 75 to 100 percent passing.
 - e. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - f. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - g. No. 16 (1.18 mm) sieve: 15 to 35 percent passing.
 - h. No. 40 (450 micro m): 10 to 25 percent passing.
 - i. No. 200 (75 micro m): 5 to 10 percent passing.
- G. Aggregate for Wearing Course: In accordance with LADOTD Standard Specifications for Roads and Bridges.
- H. Aggregate for Wearing Course: Angular crushed washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM D2487 Group Symbol GW.
 - 2. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2 inch (50 mm) sieve: 100 percent passing.
 - b. 1 inch (25 mm) sieve: 95 percent passing.
 - c. 3/4 inch (19 mm) sieve: 95 to 100 percent passing.
 - d. 5/8 inch (16 mm) sieve: 75 to 100 percent passing.
 - e. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - f. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - g. No. 16 (1.18 mm) sieve: 15 to 35 percent passing.
 - h. No. 40 (450 micro m): 10 to 25 percent passing.
 - i. No. 200 (75 micro m): 5 to 10 percent passing.
- I. Fine Aggregate: In accordance with LADOTD Standard Specifications for Roads and Bridges.
- J. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
- K. Fiber Reinforcement: Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 1/2 inch (12 mm) length.
- L. Primer: In accordance with LADOTD Standard Specifications for Roads and Bridges.
- M. Tack Coat: Homogeneous, medium curing, liquid asphalt.
- N. Seal Coat: AI MS-19, sand type.

2.03 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Use dry material to avoid foaming. Mix uniformly.
- B. Asphalt Base Course: 3.0 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- C. Asphalt Binder Course: 4.5 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- D. Asphalt Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

E. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.04 SOURCE QUALITY CONTROL

A. Test mix design and samples in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 AGGREGATE BASE COURSE

- A. Place and compact aggregate base course.
- B. See Section 321123.

3.03 PREPARATION - PRIMER

- A. Apply primer in accordance with manufacturer's instructions.
- B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).
- C. Apply primer to contact surfaces of curbs, gutters.
- D. Use clean sand to blot excess primer.

3.04 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).
- C. Apply tack coat to contact surfaces of curbs.
- D. Coat surfaces of manhole frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.05 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with LADOTD Standard Specifications for Roads and Bridges.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Install gutter drainage grilles and frames in correct position and elevation.
- D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.06 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place asphalt wearing course within two hours of placing and compacting binder course.
- C. Install gutter drainage grilles and frames in correct position and elevation.
- D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- E. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.07 SEAL COAT

A. Apply seal coat to asphalt surface course and asphalt curbs in accordance with AI MS-19.

3.08 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.
- B. Compacted Thickness: Within 1/4 inch (6 mm) of specified or indicated thickness.
- C. Variation from True Elevation: Within 1/2 inch (12 mm).

3.09 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for general requirements for quality control.
- B. Provide field inspection and testing. Take samples and perform tests in accordance with AI MS-2.

3.10 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury until surface temperature is less than 140 degrees F (60 degrees C).

3.11 SCHEDULE

- A. Pavement at Truck Ramp and Garbage Area: Single course of 3-1/2 inch (89 mm) compacted thickness, sand seal coat.
- B. Pavement at Parking Areas: Two courses; binder course of 2-1/2 inch (63 mm) compacted thickness and wearing course of 1 inch compacted thickness, fog seal coat.
- C. Pavement at Rear Bus Loading Area: Thickness and compaction of subbase to support vehicles up to 30,000 lb (13 600 kg).
- D. Pavement Front Sidewalks: Thickness and compaction of subbase to support moderate pedestrian traffic.

SECTION 321313 CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.02 RELATED REQUIREMENTS

- A. Section 031000 Concrete Forming and Accessories.
- B. Section 032000 Concrete Reinforcing.
- C. Section 033000 Cast-in-Place Concrete.
- D. Section 033533 Stamped Concrete Finishing: Additional requirements for patterned surfaces.
- E. Section 079200 Joint Sealants: Sealing joints.
- F. Section 099113 Exterior Painting: Pavement markings.
- G. Section 238300 Radiant Heating and Cooling Units: Electric cables and electric mats.
- H. Section 312200 Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- I. Section 312323 Fill: Compacted subbase for paving.
- J. Section 321123 Aggregate Base Courses
- K. Section 321216 Asphalt Paving: Asphalt wearing course.
- L. Section 321413 Precast Concrete Unit Paving.
- M. Section 321416 Brick Unit Paving.
- N. Section 321423 Asphalt Unit Paving.
- O. Section 321440 Stone Paving.
- P. Section 321450 Porcelain Unit Paving.
- Q. Section 321713 Parking Bumpers: Precast concrete parking bumpers.
- R. Section 321723 Pavement Markings.
- S. Section 321726 Tactile Warning Surfacing: Plastic tactile and detectable warning tiles for pedestrian walking surfaces.
- T. Section 330561 Concrete Manholes: Manholes, including frames; gutter drainage grilles, covers, and frames for placement by this section.
- U. Section 344100 Roadway Signaling and Control Equipment.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Provide concrete paving by the unit price method.
- B. See Section 012200 Unit Prices, for additional unit price requirements.
- C. Concrete Pavement Mix (Base): Measurement by the cubic yard (meter). Includes mix design, supplying to site, testing.
- D. Concrete Pavement Mix (Wearing Course): Measurement by the cubic yard (meter). Includes mix design, supplying to site, testing.
- E. Concrete Placed: Measurement by the square yard (meter) per inch (25 mm) thickness. Includes preparing base, placing, floating and finishing, testing.

1.04 REFERENCE STANDARDS

- A. ACI 211.1 Selecting Proportions for Normal-Density and High Density-Concrete Guide 2022.
- B. ACI 301 Specifications for Concrete Construction 2020.

- C. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- D. ACI 305R Guide to Hot Weather Concreting 2020.
- E. ACI 306R Guide to Cold Weather Concreting 2016.
- F. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2022.
- G. ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2022.
- H. ASTM C33/C33M Standard Specification for Concrete Aggregates 2018.
- I. ASTM C39/C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.
- J. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete 2022a.
- K. ASTM C150/C150M Standard Specification for Portland Cement 2022.
- L. ASTM C173/C173M Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.
- M. ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- N. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
- O. ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete 2019, with Editorial Revision (2022).
- P. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete 2022.
- Q. ASTM C685/C685M Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing 2017.
- R. ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.
- S. ASTM D1752 Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction 2018.
- T. ASTM D8139 Standard Specification for Semi-Rigid, Closed-Cell Polypropylene Foam, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction 2017.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.
- C. Samples: Submit two sample panels, 12 by 12 inch (300 by 300 mm) in size illustrating exposed aggregate finish.
- D. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

- A. Comply with applicable requirements of ACI 301.
- B. Design paving for parking and residential streets.
- C. Concrete Sidewalks and Median Barrier: 3,000 psi (20.7 MPa) 28 day concrete, 4 inches (100 mm) thick, buff color Portland cement, exposed aggregate finish.
- D. Parking Area Pavement: 4,000 psi (27.6 MPa) 28 day concrete, 5 inches (125 mm) thick, 6 by 6 W2.9 by W2.9 mesh reinforcement, wood float finish.

2.02 FORM MATERIALS

- A. Form Materials: As specified in Section 031000, comply with ACI 301.
- B. Wood form material, profiled to suit conditions.
- C. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - 1. Thickness: 1/2 inch (12 mm).

2.03 REINFORCEMENT

- A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 032000.
- B. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa) yield strength; deformed billet steel bars; unfinished.
- C. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.
- D. Dowels: ASTM A615/A615M, Grade 40 40,000 psi (280 MPa) yield strength; deformed billet steel bars; unfinished finish.

2.04 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: As specified in Section 033000.
- C. Concrete Materials: Provide in accordance with LADOTD Standard Specifications for Roads and Bridges.
- D. Cement: ASTM C150/C150M, Normal Type I Portland cement, gray color.
- E. Fine and Coarse Mix Aggregates: ASTM C33/C33M.
- F. Fly Ash: ASTM C618, Class C or F.
- G. Calcined Pozzolan: ASTM C618, Class N.
- H. Silica Fume: ACI 211.1.
- I. Water: Clean, and not detrimental to concrete.
- J. Fiber Reinforcement: Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 1/2 inch (12 mm) length.
- K. Air-Entraining Admixtures: ASTM C260/C260M.
- L. Chemical Admixtures: ASTM C494/C494M, Type A Water Reducing, Type C Accelerating, and Type G Water Reducing, High Range and Retarding.
 - 1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

2.05 ACCESSORIES

- A. Acid Etch Solution: Muriatic type mixed to a [____] percent solution.
- B. Curing Compound: ASTM C309, Type 1, Class A.
- C. Surface Retarder:
 - 1. Color: As selected by Architect from manufacturer's standard range.
 - 2. Color: As indicated.
- D. Slab Isolation Joint Filler: 1/2 inch (13 mm) thick, height equal to slab thickness, with removable top section that will form 1/2 inch (13 mm) deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.
 - 2. Material: ASTM D1752 sponge rubber (Type I).
 - 3. Material: ASTM D8139, semi-rigid, closed-cell polypropylene foam.
 - 4. Material: Closed-cell, non-absorbent, compressible polymer foam in sheet form.
 - 5. Manufacturers:

- a. Nomaco, Inc; Nomaflex Expansion Joint Filler with Void Cap Option: www.nomaco.com/#sle.
- b. Nomaco, Inc; Fastflex Slab Isolation Joint Filler with Tear-Off Strip: www.nomaco.com/#sle.
- E. Tactile Warning Surfaces: See Section 321726.

2.06 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- D. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard (0.89 kg per cubic meter), or as recommended by manufacturer for specific project conditions.
- E. Concrete Properties:
 - 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; As indicated on drawings.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
 - 4. Silica Fume Content: Maximum 5 percent of cementitious materials by weight.
 - 5. Water-Cement Ratio: Maximum 40 percent by weight.
 - 6. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 - 7. Maximum Slump: 3 inches (75 mm).

2.07 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
- B. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

- A. See Section 321123 for construction of base course for work of this Section.
- B. Prepare subbase in accordance with LADOTD Standard Specifications for Roads and Bridges.

3.03 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.
- C. Notify Architect minimum 24 hours prior to commencement of concreting operations.

3.04 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

A. Place reinforcement at top of slabs-on-grade.

- B. Place reinforcement as indicated.
- C. Interrupt reinforcement at contraction joints.
- D. Place dowels to achieve pavement and curb alignment as detailed.
- E. Provide doweled joints on center at transverse joints.

3.06 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI 305R when concreting during hot weather.
- B. Follow recommendations of ACI 306R when concreting during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.

3.07 PLACING CONCRETE

- A. Coordinate installation of snow melting components.
- B. Place concrete in accordance with ACI 304R.
- C. Place concrete in accordance with LADOTD Standard Specifications for Roads and Bridges.
- D. Do not place concrete when base surface is wet.
- E. Place concrete using the slip form technique.
- F. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- G. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- H. Place concrete to pattern indicated.
- I. Apply surface retarder to all exposed surfaces in accordance with manufacturer's instructions.

3.08 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Place 3/8 inch (10 mm) wide expansion joints at 20 foot (6 m) intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
 - 1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch (13 mm) of finished surface.
 - 2. Secure to resist movement by wet concrete.
- C. Provide scored joints.
 - 1. At 3 feet (1 m) intervals.
 - 2. Between sidewalks and curbs.
 - 3. Between curbs and pavement.
- D. Provide keyed joints as indicated.
- E. Saw cut contraction joints 3/16 inch (5 mm) wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.09 EXPOSED AGGREGATE

- A. Wash scheduled concrete surfaces with acid etch solution exposing aggregate to match sample panel.
- B. Wash concrete surfaces to which surface retarder has been applied with clean water, and scrub with stiff bristle brush exposing aggregate to match sample panel.
- C. Sand blast concrete surfaces to achieve aggregate exposure to match sample panel.
- D. Include broadcast spreading of aggregate into plastic concrete.

3.10 FINISHING

A. Area Paving: Light broom, texture perpendicular to pavement direction.

- B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius (6 mm radius).
- C. Median Barrier: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius (6 mm radius).
- D. Curbs and Gutters: Light broom, texture parallel to pavement direction.
- E. Inclined Vehicular Ramps: Broomed perpendicular to slope.
- F. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.11 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch (6 mm) in 10 ft (3 m).
- B. Maximum Variation From True Position: 1/4 inch (6 mm).

3.12 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 Quality Requirements.
 - 1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 - 3. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd (76 cu m) or less of each class of concrete placed.
 - 1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - 2. Perform one slump test for each set of test cylinders taken.
- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.13 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.
- C. Do not permit pedestrian traffic over pavement until 75 percent design strength of concrete has been achieved.

SECTION 321500 AGGREGATE SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cinder surfacing.
- B. Crushed stone surfacing.
- C. Aggregate-turf pavement.
- D. Geosynthetic surface reinforcement.

1.02 RELATED REQUIREMENTS

- A. Section 311000 Site Clearing.
- B. Section 312200 Grading: Preparation of subbase.
- C. Section 312316 Excavation.
- D. Section 312323 Fill.
- E. Section 321123 Aggregate Base Courses.
- F. Section 329219 Seeding.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Allowances: See Section 012100 Allowances for cash, testing, and quantity allowances affecting this section.
- B. Unit Prices: See Section 012200 Unit Prices for additional unit price requirements.
 - 1. Provide the work under the unit price method.
 - 2. Measure roadways by the linear foot (linear meter).

1.04 REFERENCE STANDARDS

- A. ASTM C131/C131M Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine 2020.
- B. ASTM C136/C136M Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.
- C. ASTM D638 Standard Test Method for Tensile Properties of Plastics 2022.
- D. ASTM D1603 Standard Test Method for Carbon Black Content in Olefin Plastics 2020.
- E. ASTM D1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics 2016.
- F. ASTM D4355/D4355M Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus 2021.
- G. ASTM D4873/D4873M Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples 2017 (Reapproved 2021).
- H. ASTM D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test 2020.
- I. ASTM D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods 2012 (Reapproved 2018).

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Geosynthetic Product Data: Indicate recycled content, ultraviolet stability, and compressive strength.
- C. Manufacturer's Instructions: Include aggregate base course placement, installation procedures, and fill placement.

- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.
- F. Samples: Two full-sized sections of surface reinforcement units, or minimum 1 foot (300 mm) square piece of roll reinforcement, whichever is applicable.
- G. Certificates: Certify that products of this section meet or exceed specified requirements.
- H. Maintenance Data: Manufacturer's instructions for maintenance of turf and turf reinforcement.

1.0 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in installing work of the type specified in this section, and with at least three years of documented experience and approved by manufacturer.

1.0 DELIVERY, STORAGE, AND HANDLING

- A. See Section 016000 Product Requirements for additional requirements.
- B. Identify, store, and handle geosynthetics according to ASTM D4873/D4873M.
- C. Protect geosynthetic materials from sunlight and other ultraviolet light sources during storage.
- D. Handle geosynthetics with care and prevent dragging, dropping, or imbalanced lifting.

1.0 FIELD CONDITIONS

- A. Follow recommendations of geosynthetic manufacturer.
- B. Temperature Requirements: Do not place geosynthetic when ambient air or base surface temperature is less than 40 degrees F (4 degrees C) or above 140 degrees F (60 degrees C).
- C. Surface Requirements: Do not place geosynthetic when the receiving surface is saturated or has ponded water.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cinder Surfacing: 50 percent loss maximum according to ASTM C131/C131M.
 - 1. Sieve Analysis: In accordance with ASTM C136/C136M.
 - a. 100 percent passing 1 inch (25 mm) sieve.
 - b. 80 to 95 percent passing 3/4 inch (19 mm) sieve.
 - c. 35 to 60 percent passing No.4 (4-3/4 mm) sieve.
 - d. 22 to 45 percent passing No.10 (2 mm) sieve.
 - e. 8 to 25 percent passing No.40 (17/40 mm) sieve.
 - f. 3 to 12 percent percent passing No.200 (3/40 mm) sieve.
- B. Crushed Stone Surfacing: Pit run, washed, 3/8 inch (1 cm) stone; free of shale, clay, friable material, and debris.
- C. Aggregate-Turf Pavement:
 - 1. Grass Seed, Fertilizer, and Related Materials: See Section 329219.
 - 2. Hydrogel Crystals: Nontoxic and neutral pH; fertilizer degradation resistant.
 - a. Polyacrylamide Polymer: 1/10 percent maximum.
 - b. Absorption Capacity: 150 to 350 percent weight.
 - 3. Fill: Clean, sharp sand.
- D. Geosynthetic Surface Reinforcement: Recurring pattern, interlocking, capable of retaining fill.
 - 1. Manufacturers:
 - a. Geo Products, LLC: www.geoproducts.org/ sle.
 - b. Invisible Structures, Inc; Gravelpave2: www.invisiblestructures.com/ sle.
 - c. NDS, Inc: www.ndspro.com/ sle.
 - d. Presto-Geosystems, Co: www.prestogeo.com/ sle.

- 2. Material: High density polyethylene.
- 3. Carbon Black: 1 percent, minimum, when tested in accordance with ASTM D1603.
- 4. Ultraviolet Stability: 65 percent, minimum, when tested in accordance with ASTM D4355/D4355M.
- 5. Section Width: 4 feet (1219 mm) nominal.
- 6. Section Length: 20 feet (6 m) nominal.
- 7. Category: Deep cell with large area.
 - a. Cell Depth: 3 inches (76 mm), minimum.
 - b. Perforation: Diamond.
 - c. Environmental Stress Crack Resistance: 400 hours, minimum, when tested in accordance with ASTM D5397.
 - d. Peel Strength: 240 pounds (1067 N), when tested in accordance with ASTM D6392.
- 8. Category: Shallow cell with small area.
 - a. Cell Depth: 1 inch (25 mm), minimum.
 - b. Backing: Geotextile.
 - c. Compressive Strength: 15,000 psi (103 mPa), minimum, when tested in accordance with ASTM D1621.
 - d. Tensile Strength: 150 lbf (667 N), minimum, when tested in accordance with ASTM D638.
- 9. Anchors: According to manufacturer's recommendations.
- E. Aggregate Base Course: According to surface reinforcement manufacturer's recommendations.
- F. Aggregate Base Course: See Section 321123.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that subgrade has been prepared correctly, is smooth, and is at proper grade and level.
- B. Do not begin work until subgrade is correct.

3.02 INSTALLATION

- A. Install aggregate base course according to surface reinforcement manufacturer's recommendations.
- B. Place aggregate base course, see Section 321123.
- C. Spread moisture absorbent crystals evenly over surface of aggregate base course, at rate of 5 lbs/1000 sq ft (225 kg/100 sq m); prevent wetting crystals prior to placement of aggregate-turf fill.
- D. Install surface reinforcement and aggregate surfacing or aggregate-turf pavement in accordance with manufacturer's instructions.
- E. Install surface reinforcement smooth and without overlaps or wrinkles.
 - 1. Cut sections to shape with applicable tools.
 - 2. Interlock sections at adjacent joints.
 - 3. Anchor sections to base course.
- F. Place surfacing or aggregate-turf pavement 2 inches (50 mm) above top of reinforcement, see Section 312323.
- G. Place surfacing or aggregate-turf pavement flush with top of reinforcement, see Section 312323.
- H. Place surfacing or aggregate-turf pavement in maximum 4 inch (100 mm) layers.1. Roller compact to specified density.
- I. Spread grass seed, fertilizer, and related materials, see Section 329219.

3.03 CLEANING

- A. See Section 017419 Construction Waste Management and Disposal for additional requirements.
- B. Remove unused or stockpiled fill, base, and reinforcement.
- C. Clean adjacent surfaces of excess sand, gravel, soil, and debris. Sweep broom clean.

3.04 PROTECTION

A. Protect turf from traffic other than emergency vehicles for minimum of 8 weeks, or until the root system has penetrated and established grass well below the turf reinforcement units.

SECTION 321623 SIDEWALKS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Asphalt sidewalks.
- B. Concrete sidewalks.
- C. Concrete wheelchair ramps.
- D. Unit paving sidewalks.

1.02 RELATED REQUIREMENTS

- A. Section 321123 Aggregate Base Courses.
- B. Section 321726 Tactile Warning Surfacing.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Provide concrete sidewalk paving by the unit price method.
- B. See Section 012200 Unit Prices, for additional unit price requirements.
- C. Concrete for Sidewalks: Measurement by the square yard (sq m). Includes mix design, supplying to site, preparing base, placing, floating, finishing and verification.
- D. Concrete for Wheelchair Ramps: Measurement by each. Includes mix design, supplying to site, preparing base, placing, floating, finishing and verification.
- E. Alternates: See Section 012300 Alternates, for product alternatives affecting this section.

1.04 REFERENCE STANDARDS

- A. ACI 211.1 Selecting Proportions for Normal-Density and High Density-Concrete Guide 2022.
- B. ACI 305R Guide to Hot Weather Concreting 2020.
- C. ACI 306R Guide to Cold Weather Concreting 2016.
- D. ADA Standards 2010 ADA Standards for Accessible Design 2010.
- E. AI MS-19 Basic Asphalt Emulsion Manual 2008.
- F. ANSI A137.1 American National Standard Specifications for Ceramic Tile 2022.
- G. ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2022.
- H. ASTM C33/C33M Standard Specification for Concrete Aggregates 2018.
- I. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete 2022a.
- J. ASTM C144 Standard Specification for Aggregate for Masonry Mortar 2018.
- K. ASTM C157/C157M Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete 2017.
- L. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
- M. ASTM C902 Standard Specification for Pedestrian and Light Traffic Paving Brick 2022.
- N. ASTM C936/C936M Standard Specification for Solid Concrete Interlocking Paving Units 2021b.
- O. ASTM C1315 Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete 2019.
- P. ASTM C1116/C1116M Standard Specification for Fiber-Reinforced Concrete 2010a (Reapproved 2015).
- Q. ASTM D946/D946M Standard Specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction 2020.

- R. ASTM C1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) 2021.
- S. ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.
- T. ASTM D1752 Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction 2018.
- U. ASTM D5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter 2016a.
- V. ASTM D5268 Standard Specification for Topsoil Used for Landscaping and Construction Purposes 2022.
- W. ASTM D8139 Standard Specification for Semi-Rigid, Closed-Cell Polypropylene Foam, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction 2017.
- X. COE CRD-C 48 Handbook for Concrete and Cement Standard Test Method for Water Permeability of Concrete 1992.
- Y. NSF 372 Drinking Water System Components Lead Content 2022.
- Z. NSF 61 Drinking Water System Components Health Effects 2022, with Errata.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Asphalt: Provide data on primer.
 - 2. Concrete: Provide data on admixtures.
 - 3. Paver: Provide data on joint filler.
- C. Samples: Submit two sample paver units indicating color, surface finish, and texture.
- D. Design Data: Indicate pavement thickness, design strength, reinforcement, and typical details.
- E. Weather Data: Records during placement of asphalt or concrete, including date, location of placement, quantity, and air temperature.

1.06 FIELD CONDITIONS

- A. Temperature Requirements: Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.
- B. Follow recommendations of ACI 305R and ACI 306R when concreting during hot and cold weather, respectively.
- C. Follow recommendations of polymeric sand manufacturer.

PART 2 PRODUCTS

2.01 ASPHALT SIDEWALKS

- A. Gravel Subbase: Thickness as indicated on drawings.
- B. Asphalt Cement: ASTM D946/D946M.
- C. Aggregate:
 - 1. Single Course: Pit run, washed, 3/8 inch (1 cm) stone; free of shale, clay, friable material and debris.
- D. Aggregate:
 - 1. Base Course: Pit run, washed, 3/4 inch (2 cm) stone, free of shale, clay, friable material and debris.
 - 2. Wearing Course: Pit run, washed, 1/2 inch (1.3 cm) stone; free of shale, clay, friable material and debris.
- E. Primer: Homogenous, medium curing, liquid asphalt.
- F. Tack Coat: Homogenous, medium curing, liquid asphalt.

- G. Seal Coat: AI MS-19, sand type.
- H. Tactile Warning Surfaces: See Section 321726.

2.02 CONCRETE SIDEWALKS AND WHEELCHAIR RAMPS

- A. Gravel Subbase: Thickness as indicated on drawings.
- B. Concrete Forms: Wood.
- C. Concrete Materials: Comply with ASTM C94/C94M.
- D. Aggregate: Pit Run, washed, 3/8 inch (1 cm) stone; free of shale, clay, friable material and debris.
- E. Reinforcement:
 - 1. Steel Welded Wire Reinforcement: ASTM A1064/A1064M, plain type, flat sheets, unfinished.
 - 2. Fiber Reinforcement: 1 percent, steel fibers, according to ASTM C1116/C1116M.
- F. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 - 1. Permeability of Cured Concrete: No measurable leakage when tested in accordance with COE CRD-C 48 at 200 psi (1.38 MPa); provide test reports.
 - Manufacturers:
 a. Barrier One Concrete Admixtures; WPX Water Proofer: www.barrierone.com/#sle.
- G. Joint Filler: Preformed expansion, with a thickness of 1/2 inch (13 mm).
- H. Curing Compound: Synthetic, Type 1, Class A, according to ASTM C309.
- I. Surface Sealer: Topical, Type 1, Class A, according to ASTM C1315.
- J. Tactile Warning Surfaces: See Section 321726.

2.03 UNIT PAVING SIDEWALKS

- A. Gravel Subbase: Thickness as indicated on drawings.
- B. Sand for Setting Bed: Clean washed natural sand or crushed stone complying with gradation requirements of ASTM C33/C33M for fine aggregates.
- C. Precast Unit Pavers: Solid and interlocking, complying with ASTM C936/C936M.
 - 1. Size: 12 by 12 inches (305 by 305 mm).
 - 2. Thickness: 2-3/8 inches (60 mm).
 - 3. Color: Natural.
 - 4. Color: Selected by Architect from manufacturer's standard range.
 - 5. Compressive Strength: 3000 pounds per square inch (20.7 MPa), average.
- D. Brick Unit Pavers: Solid and interlocking, complying with ASTM C902.
 - 1. Size: 3-5/8 by 7-5/8 inches (92 by 203 mm).
 - 2. Thickness: 2-1/4 inches (57 mm).
 - 3. Color: Red.
 - 4. Color: Selected by Architect from manufacturer's standard range.
 - 5. Compressive Strength: 3000 pounds per square inch (20.7 MPa), average.
- E. Porcelain Unit Pavers: Solid and interlocking, complying with ANSI A137.1.
 - 1. Size: 24 by 24 inches (610 by 610 mm).
 - 2. Thickness: 3/4 inch (20 mm).
 - 3. Color: Natural.
 - 4. Color: Selected by Architect from manufacturer's standard range.
 - 5. Special Shapes: Selected by Architect from manufacturer's standard range.
 - 6. Manufacturers:
 - a. Hardscape.com; 2cm Porcelain Paver: www.hardscape.com/#sle.
- F. Joint Spacers: Manufacturer's standard permanent joint spacer.

- G. Sand for Joints: Fine washed sand with 100 percent passing No.16 (1.18 mm) sieve and not more than 10 percent passing No.200 (0.075 mm) sieve.
- H. Polymeric Sand: Fine sand complying with ASTM C144 combined with polymer binders for creating semi-solid joints between pavers.
 - 1. Material: Granite.
 - 2. Additive(s): Portland Cement.
 - 3. Compressive Strength: 750 pounds per square inch (5 MPa).
 - 4. Adhesion by Tensile Load: 100 pounds per square inch (0.7 MPa).
 - 5. Color: Beige.
- I. Edging: Formed aluminum, as detailed.
- J. Detectable Warning Pavers: Cast concrete with truncated domes, yellow.

2.04 ACCESSORIES

- A. Landscape Aggregates: Epoxy-coated round or polished aggregates.
 - 1. Color: As selected by Architect from manufacturer's standard range.
 - 2. Size: As selected by Architect from manufacturer's standard range.
 - 3. Products:
 - a. Coverall Stone; Decorative Pebbles: www.coverallstone.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify gradients and elevations of the subgrade are correct as shown on drawings. Where poor subgrade material is encountered, remove and replace with suitable material.
- B. Verify compacted subgrade is acceptable, ready to support imposed loads and paving, and ready to receive work.

3.02 SUBBASE PREPARATION

- A. Maintain subgrade in a smooth, compacted condition with required section and established grade until concrete is placed.
- B. See Section 321123 for aggregate subbase.
- C. Apply primer on aggregate subbase at uniform rate of 1/3 gallon per square yard (1.5 L/sq m).

3.03 ASPHALT SIDEWALK INSTALLATION

- A. Place asphalt within 24 hours of applying primer or tack coat.
- B. For single course, place to thickness shown in the drawings.
- C. For double course, place wearing course within two hours of placing and compacting base course.
- D. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gallons per square yard (1.5 L/sq m).
- E. Compact to specified density. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.
- F. Apply seal coat to surface course in accordance with AI MS-19.
- G. Record weather information for placement.

3.04 CONCRETE SIDEWALK AND WHEELCHAIR RAMP INSTALLATION

- A. Mixing:
 - 1. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
 - 2. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- B. Forming:
 - 1. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

- B. Forming:
 - 1. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
 - 2. Sidewalk Forms: Place and secure forms to location, dimension, profile, and gradient shown on drawings. Height equal to the full depth of the finished sidewalk.
 - 3. Wheelchair Ramps: Place and secure forms to location, dimension, profile, and gradient shown on drawings. Comply with ADA Standards.
- C. Reinforcement:
 - 1. Place wire-mesh reinforcement mid-height of forms.
 - 2. Uniformly add fiber reinforcement to concrete mix according to manufacturer's recommendations.
- D. Placement:
 - 1. Place concrete in a single lift.
 - 2. Consolidate concrete by tamping and spading.
 - 3. Install work in accordance with LCG Standard Specifications for Roads and Bridges.
- E. Joints:
 - 1. Spacing: Provide scored joints every 10 feet (3 m).
 - 2. Provide keyed joints as indicated.
 - 3. Filler height equal to the full depth of the finished concrete.
- F. Finishing:
 - 1. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge, 1/4 inch radius (6 mm radius).
 - 2. Wheelchair Ramps: Broomed perpendicular to slope.
 - 3. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.
 - 4. Place surface sealer on exposed concrete surfaces after hardening. Apply in accordance with manufacturer's instructions.
- G. Record weather information for placement.

3.05 UNIT PAVING SIDEWALK INSTALLATION

- A. Spread sand bedding evenly over prepared substrate surface to a maximum thickness of 1-1/2 inch (38 mm).
- B. Dampen and roller compact bed sand to level and even surface.
- C. Place paver units in herringbone pattern creating staggered joints, from straight reference edge.
- D. Cut paver units at edges with masonry saw.
- E. Tamp and level paver units with mechanical vibrator until units are firmly bedded, level, and to correct elevation and gradients. Do not tamp unrestrained edges.
- F. Sprinkle sand over surface and sweep into joints. Moisten joints and recover with additional sand until firm joints are achieved. Remove excess sand.
- G. Install polymeric sand according to manufacturer's recommendations.
- H. Record weather information for placement.

3.0 TOLERANCES

- A. Surface Flatness: 1/4 inch (6 mm), maximum, measured with 10 foot (3 m) straight edge.
- B. Variation from True Position: 1/4 inch (6 mm), maximum.
- C. Compacted Thickness: Within 1/4 inch (6 mm) of specified or indicated thickness.

3.0 PROTECTION

A. Immediately after placement, protect sidewalk from premature drying, excessively hot or cold temperatures, and mechanical injury.

SECTION 321713 PARKING BUMPERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete parking bumpers and anchorage.

1.02 RELATED REQUIREMENTS

A. Section 321723 - Pavement Markings.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 012200 Unit Prices, for additional unit price requirements.
- B. Parking Bumpers:
 - 1. Basis of Measurement: By the unit.
 - 2. Basis of Payment: Includes bumper unit, installed.

1.04 REFERENCE STANDARDS

- A. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2022.
- B. ASTM C33/C33M Standard Specification for Concrete Aggregates 2018.
- C. ASTM C150/C150M Standard Specification for Portland Cement 2022.
- D. ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- E. ASTM C330/C330M Standard Specification for Lightweight Aggregates for Structural Concrete 2017a.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide unit configuration, dimensions.
- C. Samples: Submit two concrete bumper units, illustrating surface finish.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Parking Bumpers: Precast concrete, complying with the following:
 - 1. Cement: ASTM C150/C150M, Portland Type I Normal; white color.
 - 2. Concrete Materials: ASTM C330/C330M aggregate, water, and sand.
 - 3. Reinforcing Steel: ASTM A615/A615M, deformed steel bars; unfinished, strength and size commensurate with precast unit design.
 - 4. Air Entrainment Admixture: ASTM C260/C260M.
 - 5. Concrete Mix: Minimum 5,000 psi (34 MPa) compressive strength after 28 days, air entrained to 5 to 7 percent.
 - 6. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture.
 - 7. Embed reinforcing steel, and drill or sleeve for two dowels.
 - 8. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
 - 9. Minor patching in plant is acceptable, providing appearance of units is not impaired.
 - 10. Sand blast exposed-to-view precast unit surfaces to medium exposure.
- B. Parking Bumpers: Preservative pressure treated, species wood, pre-drilled for two dowels.
 1. Profile: Manufacturer's standard.
- C. Dowels: Steel, unfinished; 1/2 inch (12 mm) diameter, pointed tip.
- D. Dowels: Cut reinforcing steel, 1/2 inch (12 mm) diameter, pointed tip.
- E. Adhesive: Epoxy type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install units without damage to shape or finish. Replace or repair damaged units.
- B. Install units in alignment with adjacent work.
- C. Fasten units in place with 2 dowels per unit.

SECTION 321723 PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Painted pavement markings.
- B. Raised pavement markings.
- C. Plastic pavement markings.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Allowances:
 - 1. See Section 012100 Allowances for allowances affecting this section.
 - 2. Include cash allowance for pavement markings.

B. Unit Prices:

- 1. See Section 012200 Unit Prices for additional requirements.
- 2. Basis of Measurement for Linear Painted or Plastic Pavement Markings: By linear foot (linear meter).
- 3. Basis of Measurement for Painted or Plastic Pavement Markings Symbols or Text: Per unit.
- 4. Basis of Measurement for Raised Pavement Markings: Per unit.

1.03 REFERENCE STANDARDS

- A. AASHTO M 237 Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete 2005 (Reapproved 2019).
- B. AASHTO M 247 Standard Specification for Glass Beads Used in Pavement Markings 2013 (Reapproved 2018).
- C. AASHTO M 249 Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form) 2012 (Reapproved 2020).
- D. AASHTO MP 24 Standard Specification for Waterborne White and Yellow Traffic Paints 2015 (Reapproved 2020).
- E. ASTM D4505 Standard Specification for Preformed Retroreflective Pavement Marking Tape for Extended Service Life 2012 (Reapproved 2017).
- F. ASTM E303 Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester 1993 (Reapproved 2018).
- G. FHWA MUTCD Manual on Uniform Traffic Control Devices 2010, with Errata.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work of this section with adjoining work.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by affected installers.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate survey control points and pavement markings.
- C. Shop Drawings: Indicate traffic management plan with barricades, cones, and temporary markings.
- D. Product Data: Manufacturer's data sheets on each product to be used.
- E. Certificates: Submit for each batch stating compliance with specified requirements.
 - 1. Painted pavement markings.
 - 2. Raised pavement markings.
 - 3. Plastic pavement markings.

- F. Manufacturer's Instructions:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 Product Requirements for additional provisions.
 - 2. Extra Paint: 2 containers, 1 gallon (4 liter) size, of each type and color.
 - 3. Extra Markers: 5 percent, of each type and color.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons (18 L) accompanied by batch certificate.
- B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment, accompanied by batch certificate.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.08 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F (10 degrees C) or more than 95 degrees F (35 degrees C).

1.09 SEQUENCING

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

2.01 PAINTED PAVEMENT MARKINGS

- A. Comply with LADOTD Standard Specifications for Roads and Bridges.
- B. Comply with FHWA MUTCD.
- C. Painted Pavement Markings: As indicated on drawings.
 - 1. Marking Paint: In accordance with AASHTO MP 24.
 - a. Parking Lots: Yellow.
 - b. Symbols and Text: White.
 - c. Wheelchair Symbols: Provide blue and white.
 - 2. Reflective Glass Beads: Type 1, in accordance with AASHTO M 247.
 - 3. Obliterating Paint: Type I, in accordance with AASHTO MP 24.
 - a. Bituminous Pavement: Black.
 - b. Concrete Pavement: Gray.

2.02 RAISED PAVEMENT MARKINGS

- A. Comply with LADOTD Standard Specifications for Roads and Bridges.
- B. Comply with FHWA MUTCD.
- C. Surface Reflectors: Bidirectional, visible to approaching traffic; capable of withstanding pavement-rated loading.

- 1. Housing: Plastic, yellow.
- 2. Lens: Prismatic, acrylic, yellow.
- 3. Dimensions: 4 inches by 4 inches (102 mm by 102 mm).
- 4. Mounting Adhesive: Type I, in accordance with AASHTO M 237.
- 5. Pavement Projection: 1/2 inch (12 mm).
- D. Delineator Posts: All-direction visibility, reboundable.
 - 1. Upright:
 - a. Material: Polypropylene.
 - b. Height: 24 inches (610 mm).
 - c. Width: 3 inches (76 mm).
 - d. Color: Orange.
 - e. Reflective Bands: Two bands.
 - f. Shape: Round.
 - 2. Base:
 - a. Material: Acrylonitrile butadiene styrene.
 - b. Mounting Holes: 1/4 inch (6 mm).
 - 3. Mounting Hardware: Stainless steel.
 - 4. Mounting Adhesive: Type I, in accordance with AASHTO M 237.

2.03 PLASTIC PAVEMENT MARKINGS

- A. Comply with LADOTD Standard Specifications for Roads and Bridges.
- B. Comply with FHWA MUTCD.
- C. Plastic Pavement Markings: Preformed, uniform, smooth edges.
 - 1. Marking Tape: Vinyl, with retroreflective beads, in accordance with ASTM D4505.
 - a. Class: Class 1, in accordance with ASTM D4505.
 - b. Color: Yellow.
 - c. Retroreflectivity: Retroreflectivity II, in accordance with ASTM D4505.
 - d. Skid Resistance: Level B, in accordance with ASTM E303.
 - e. Thickness: 60 mils, 0.06 inch (1.5 mm).
 - f. Width: 4 inches (102 mm).
 - g. Primer: As recommended by manufacturer.
 - 2. Thermoplastic Markings: Alkyd, in accordance with AASHTO M 249.
 - a. Color: Yellow.
 - b. Reflective Glass Beads: Type 1, in accordance with AASHTO M 247.
 - c. Existing-Pavement Primer: Asphalt, thermosetting adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify existing markings for removal.
- B. Verification of Conditions: Verify that pavement is dry and ready for installation.
- C. Notify Architect of unsatisfactory conditions before proceeding.

3.02 PREPARATION

- A. Establish survey control points for locating and dimensioning of markings.
- B. Place barricades, warning signs, and flags as necessary to alert approaching traffic.
- C. Clean surfaces prior to installation.
 - 1. Remove dust, dirt, and other debris.
 - 2. Remove rubber deposits, existing paint markings, and other coatings.
- D. Temporary Markings: Apply as directed by Architect.
- E. Apply paint stencils by type and color at necessary intervals.

3.03 INSTALLATION

A. General:

- 1. Position pavement markings as indicated on drawings.
- 2. Field location adjustments require approval of Architect.
- 3. Allow traffic movement without hindrance.
- B. Painted Pavement Markings:
 - 1. Apply in accordance with manufacturer's instructions.
 - 2. Apply in accordance with LADOTD Standard Specifications for Roads and Bridges.
 - 3. Apply in accordance with FHWA MUTCD standards.
 - 4. Obliterating Paint: Apply as necessary to cover existing markings completely.
 - 5. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
 - b. Wet Film Thickness: 0.015 inch (0.4 mm), minimum.
 - c. Stencils: Lay flat against pavement, align with striping, remove after application.
 - d. Glass Beads: Apply directly to paint, 10 second lag time, 6 lbs/gal (720 g/L) of paint, uniform thickness and coverage.
 - e. Length Tolerance: Plus or minus 3 inches (75 mm).
 - f. Width Tolerance: Plus or minus 1/8 inch (3 mm).
- C. Raised Pavement Markings:
 - 1. Install in accordance with manufacturer's instructions in manner necessary to maintain manufacturer's warranty.
 - 2. Install in accordance with LADOTD Standard Specifications for Roads and Bridges.
 - 3. Install in accordance with FHWA MUTCD standards.
 - 4. Surface Reflectors:
 - a. Cut pavement and remove depth equal to height of reflector.
 - b. Partially fill area with road marker epoxy adhesive.
 - c. Press reflector into adhesive and apply pressure.
 - 5. Delineator Posts:
 - a. Base: Drill anchor holes into pavement. Place anchor sleeves into anchor holes flush with pavement surface. Screw anchor bolts through base holes into anchor sleeves.
 1) Apply mounting adhesive to base underside before anchoring.
 - b. Upright: Attach post to base before anchoring in place.
- D. Plastic Pavement Markings:
 - 1. Install in accordance with manufacturer's instructions in manner necessary to maintain manufacturer's warranty.
 - 2. Install in accordance with LADOTD Standard Specifications for Roads and Bridges.
 - 3. Install in accordance with FHWA MUTCD standards.
 - 4. Marking Tape: Place tape on pavement smooth and without wrinkles. 1/4 inch (6 mm) maximum gap between adjacent pieces. Immediately apply uniform pressure until firmly adhered.
 - a. Apply primer to pavement at a rate of 1 oz/sq ft (3 L/sq m) and allow to set for 10 minutes prior to taping.
 - 5. Thermoplastic Markings: Preheat pavement surface to 275 degrees F (135 degrees C). Place markings on pavement smooth and without wrinkles. 1/4 inch (6 mm) maximum gap between adjacent markings. Uniformly heat markings between 400 degrees F (204 degrees C) to 440 degrees F (227 degrees C). Do not overheat, scorch, or disperse embedded glass beads.
 - a. Apply primer according to manufacturer's recommendations.

3.04 TOLERANCES

- A. Maximum Variation From True Position: 3 inches (76 mm).
- B. Maximum Offset From True Alignment: 3 inches (76 mm).

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements for additional requirements.
- B. Perform field inspection for deviations from true alignment or material irregularities.

- C. If inspections indicate work does not meet specified requirements, rework and reinspect at no cost to Owner.
- D. Allow the pavement marking to set at least the minimum time recommended by manufacturer.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 017800 Closeout Submittals for additional requirements.
- B. Temporary Markings: Remove without damaging surfaces.

3.07 PROTECTION

- A. Prevent approaching traffic from crossing newly applied pavement markings.
- B. Replace damaged or removed markings at no additional cost to Owner.
- C. Preserve survey control points until pavement marking acceptance.

SECTION 321726 TACTILE WARNING SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for sidewalks and platforms.

1.03 REFERENCE STANDARDS

- A. 49 CFR 37 Transportation Services for Individuals with Disabilities (ADA) current edition.
- B. AASHTO LRFD Bridge Design Specifications 2020.
- C. ADA Standards 2010 ADA Standards for Accessible Design 2010.
- D. ASTM A48/A48M Standard Specification for Gray Iron Castings 2022.
- E. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- F. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
- G. ASTM C501 Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser 2021.
- H. ASTM C903 Standard Practice for Preparing Refractory Specimens by Cold Gunning 2015 (Reapproved 2020).
- I. ASTM D2047 Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine 2017.
- J. ASTM D543 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents 2021.
- K. ASTM D570 Standard Test Method for Water Absorption of Plastics 2022.
- L. ASTM D638 Standard Test Method for Tensile Properties of Plastics 2022.
- M. ASTM D695 Standard Test Method for Compressive Properties of Rigid Plastics 2015.
- N. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials 2017.
- O. ASTM D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems 2020.
- P. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- Q. ASTM G155 Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials 2021.
- R. ATBCB PROWAG Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way 2011.
- S. SAE AMS-STD-595 Colors Used in Government Procurement 2017a.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's product data, standard details, details specific to this project; written installation and maintenance instructions.
- C. Samples: For each product specified provide two samples, 8 inches (203 mm) square, minimum; show actual product, color, and patterns.
- D. Shop Drawings: Submit plan and detail drawings. Indicate:

- 1. Locations on project site. Demonstrate compliance with referenced accessibility standards.
- 2. Sizes and layout.
- 3. Pattern spacing and orientation.
- 4. Attachment and fastener details, if applicable
- E. Manufacturer's Qualification Statement.
- F. Installer's Qualification Statement.
- G. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years documented experience.
- B. Installer Qualifications: Company certified in writing by product manufacturer as having successfully completed work substantially similar to the work of this section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F (4 and 32 degrees C).

1.07 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Cast Iron Tiles: Provide manufacturer's standard ten year warranty against manufacturing defects, breakage or deformation.
- C. Plastic Tiles: Provide manufacturer's standard five year warranty against manufacturing defects, breakage or deformation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Plastic Tactile and Detectable Warning Surface Tiles:
 - 1. Access Tile, a brand of Access Products, Inc: www.accessproducts.com/#sle.
 - 2. ADA Solutions, a division of SureWerx USA: www.adatile.com/#sle.
 - 3. Armor-Tile, a brand of Engineered Plastics, Inc.: www.armortiletransit.com/#sle.
- B. Cast Iron Detectable Warning Plates:
 - 1. ADA Solutions, a division of SureWerx USA: www.adatile.com/#sle.
 - 2. EJ: www.ejco.com/#sle.
 - 3. Neenah Foundry, a division of Neenah Enterprises, Inc: www.nfco.com/#sle.

2.02 TACTILE AND DETECTABLE WARNING DEVICES

- A. Plastic Tactile and Detectable Warning Tiles: ADA Standards compliant, glass fiber and carbon fiber reinforced, exterior grade, matte finish polyester sheet with truncated dome pattern, solid color throughout, internal reinforcing of sheet and of truncated domes, integral radius cut lines on back face of tile; with factory-applied removable protective sheeting.
 - 1. Material Properties:
 - a. Water Absorption: 0.20 percent, maximum, when tested in accordance with ASTM D570.
 - b. Slip Resistance: 0.50 minimum dry static coefficient of friction, when tested in accordance with ASTM D2047.
 - c. Compressive Strength: 25,000 pounds per square inch (172 MPa), minimum, when tested in accordance with ASTM D695.

- d. Tensile Strength: 10,000 pounds per square inch (69 MPa), minimum, when tested in accordance with ASTM D638.
- e. Flexural Strength: 25,000 pounds per square inch (172 MPa) minimum, when tested in accordance with ASTM D790.
- f. Chemical Stain Resistance: No reaction to 1 percent hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, or antifreeze, when tested in accordance with ASTM D543.
- g. Chemical Stain Resistance: No reaction to 1 percent hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, or antifreeze, when tested in accordance with ASTM D1308.
- h. Abrasion Resistance: 300, minimum, when tested in accordance with ASTM C501.
- i. Flame Spread Index: 25, maximum, when tested in accordance with ASTM E84.
- j. Accelerated Weathering: Delta-E of less than 5.0 at 2,000 hours exposure, when tested in accordance with ASTM G155.
- Adhesion: No delamination of tile prior to board failure in a temperature range of 20 to 180 degrees F (minus 7 to 82 degrees C), when tested in accordance with ASTM C903.
- I. Loading: No damage when tested according to AASHTO LRFD test method HS20.
- m. Salt and Spray Performance: No deterioration or other defect after 200 hours of exposure, when tested in accordance with ASTM B117.
- 2. Installation Method: Cast in place.
- 3. Shape: Rectangular.
- 4. Dimensions: 24 inches by 48 inches (610 mm by 1220 mm).
- 5. Dimensions: 24 inches by 33-1/4 inches (610 mm by 844 mm) with a radius of 11 feet, 6 inches (3.5 m).
- 6. Pattern: In-line pattern of truncated domes complying with ADA Standards.
- 7. Edge: Square.
- 8. Joint: Butt.
- 9. Color: As selected by Architect from manufacturer's standard range.
- 10. Color: SAE AMS-STD-595, Table IV, Federal Yellow No. 33538.
- 11. Color: Pantone #7529C Houston Beige.
- 12. Products:
 - a. Access Tile, a brand of Access Products, Inc; Cast in Place Replaceable Tactile Warning Tile: www.accesstile.com/#sle.
 - b. ADA Solutions, a division of SureWerx USA; Radius Systems Surface Applied: www.adatile.com/#sle.
 - c. ADA Solutions, a division of SureWerx USA; Radius Systems Cast in Place Replaceable: www.adatile.com/#sle.
 - d. ADA Solutions, a division of SureWerx USA; Cast in Place (Wet-Set): www.adatile.com/#sle.
 - e. ADA Solutions, a division of SureWerx USA; Cast in Place Replaceable (Wet-Set): www.adatile.com/#sle.
 - f. ADA Solutions, a division of SureWerx USA; Surface Applied System: www.adatile.com/#sle.
 - g. ADA Solutions, a division of SureWerx USA; Transit Use In-Line Dome Surface Applied System: www.adatile.com/#sle.
 - h. ADA Solutions, a division of SureWerx USA; Transit Use Staggered Dome Surface Applied System: www.adatile.com/#sle.
- B. Cast Iron Detectable Warning Plates:
 - 1. Material: Cast gray iron; ASTM A48/A48M, Class 30 A (minimum).
 - 2. Installation Method: Cast in place.
 - 3. Shape: Rectangular and Radius.
 - 4. Square Dimensions: 24 inches square (610 mm square).
 - 5. Radius Dimensions: 24 inches (610 mm) wide, 9 feet, 5 inch (2.87 m) radius.
 - 6. Pattern: Truncated cones in compliance with ADA Standards.

- 7. Joint: Manufacturer standard, bolted connection.
- 8. Finish: Manufacturer's factory-applied powder coat.
- 9. Color: As selected by Architect from manufacturer's standard range.
- 10. Color: SAE AMS-STD-595, Table IV, Federal Yellow No. 33538.
- 11. Products:
 - a. Neenah Foundry, a division of Neenah Enterprises, Inc; www.nfco.com/#sle.

2.03 ACCESSORIES

- A. Fasteners: ASTM A666, Type 304 stainless steel
 - 1. Type: Countersunk, color matched composite sleeve anchors
 - 2. Size: 1/4 inch (6.35 mm) diameter and 1-1/2 inches (38 mm) long.
- B. Adhesive: Type recommended and approved by surfacing tile manufacturer.
- C. Sealant: Elastomeric sealant of color to match adjacent surfaces; approved by surfacing tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. When installation location is near site boundary or property line, verify required location using property survey.
- B. Verify that work area is ready to receive work:
 - 1. Examine work area with installer present.
 - 2. If existing conditions are not as required to properly complete the work of this section, notify Architect.
 - 3. Do not proceed with installation until deficiencies in existing conditions have been corrected.
- C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.02 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's written instructions.
 - 1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
 - 2. Do not install when ambient or substrate temperature has been below 40 degrees F (4 degrees C) during the preceding 8 daylight hours.
- B. Field Adjustment:
 - 1. Cut units to size and configuration shown on drawings.
 - 2. Do not cut plastic tiles to less than 9 inches (228 mm) wide in any direction.
 - 3. Locate relative to curb line in compliance with ATBCB PROWAG, Sections 304 and 305.
 - 4. Orient so dome pattern is aligned with the direction of ramp.
 - 5. Align truncated dome pattern between adjacent units.
- C. Install units fully seated to substrate, square to straight edges and flat to required slope.
- D. Align units so that tops of adjacent units are flush and joints between units are uniform in width.

3.03 INSTALLATION, CAST IN PLACE PLASTIC TILES

- A. Concrete:
 - 1. See Section 033000.
 - 2. Slump: 4 to 7 percent.
- B. When installing multiple adjacent units, leave a 3/16 inch (5 mm) gap between units to allow for expansion.
- C. Tamp and vibrate units as recommended by manufacturer.
- D. Place and position weights on units while concrete cures as recommended by manufacturer. Ensure no voids or air pockets exist between top surface of concrete and underside of units.

3.04 INSTALLATION, SURFACE APPLIED PLASTIC TILES

- A. Cure concrete surfaces for a minimum of 4 days before installing units.
- B. Verify substrate is clean and dry; free of voids, projections and loose material. Remove dust, oil, grease, curing compounds, sealers and other substances that may interfere with adhesive bond or sealant adhesion.
- C. Mechanically roughen surface as required to remove contaminants and prepare surface for adhesive and sealant application.
- D. When installing multiple adjacent units, leave a 1/8 inch (3 mm) gap between tiles to allow for expansion.
- E. Drill fastener holes straight, true and to depth recommended by manufacturer.
- F. Apply adhesive to back of unit as recommended by manufacturer.
- G. Mechanically fasten to substrate. Avoid striking or damaging the unit itself during installation.
- H. Apply sealant to edges in cove profile.

3.05 INSTALLATION - CAST IN PLACE, CAST IRON PLATES

- A. Concrete: See Section 033000.
- B. When installing multiple adjacent units, connect plates before placing.
- C. Install by method described in manufacturer's written instructions.
- D. Place units into wet concrete.
- E. Press assembly into concrete to achieve final elevation.
- F. Finish concrete adjacent to plate. Remove wet concrete spilled onto plate surface.

3.06 CLEANING PLASTIC UNITS

- A. Remove protective plastic sheeting within 24 hours of installation.
- B. Remove excess sealant or adhesive from joints and edges.
- C. Clean four days prior to date of scheduled inspection.

3.07 PROTECTION

- A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
- B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

SECTION 323223 SEGMENTAL RETAINING WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop drawings.
- B. Retaining wall units.
- C. Cap units.
- D. Shear connectors.
- E. Soil reinforcement.
- F. Drainage filter.
- G. Aggregate for leveling pad.
- H. Concrete for leveling pad.
- I. Drainage fill.
- J. Reinforced backfill.
- K. Drainage pipe.

1.02 RELATED REQUIREMENTS

- A. Section 312323 Fill.
- B. Section 334100 Subdrainage.

1.03 REFERENCE STANDARDS

- A. AASHTO M 288 Standard Specification for Geosynthetic Specification for Highway Applications 2022.
- B. ASTM C140/C140M Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units 2022b.
- C. ASTM C150/C150M Standard Specification for Portland Cement 2022.
- D. ASTM C920 Standard Specification for Elastomeric Joint Sealants 2018.
- E. ASTM C1262/C1262M Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units 2018.
- F. ASTM C1372 Standard Specification for Dry-Cast Segmental Retaining Wall Units 2017.
- G. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012 (Reapproved 2021).
- H. ASTM D1241 Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses 2015.
- I. ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil 2016.
- J. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision (2020).
- K. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).
- L. ASTM D4355/D4355M Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus 2021.
- M. ASTM D4491/D4491M Standard Test Methods for Water Permeability of Geotextiles by Permittivity 2022.
- N. ASTM D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method 2017.
- O. ASTM D4632/D4632M Standard Test Method for Grab Breaking Load and Elongation of Geotextiles 2015a.
- P. ASTM D4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile 2021a.
- Q. ASTM D5262 Standard Test Method for Determining the Unconfined Tension Creep and Creep Rupture Behavior of Planar Geosynthetics Used for Reinforcement Purposes 2021.
- R. ASTM D5321/D5321M Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear 2021.
- S. ASTM D5818 Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics 2011 (Reapproved 2022).
- T. ASTM D6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks) 2018.
- U. ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis 2021, with Editorial Revision.
- V. FHWA NHI-10-024 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Volume I 2009.
- W. FHWA NHI-10-025 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Volume II 2009.
- X. NCMA TR-127 Design Manual for Segmental Retaining Walls 3rd Edition 2010.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Segmental Retaining Wall Units:
 - 1. Manufacturer's product data.
 - 2. ICC-ES evaluation report.
 - 3. Test data on unit strength and shear resistance between units.
 - 4. Test data on soil reinforcement connection.
 - 5. Manufacturer's certification that units meet requirements of specification.
 - 6. Storage and handling requirements and recommendations.
 - 7. Installation methods.
- C. Soil Reinforcement:
 - 1. Manufacturer's product data.
 - 2. ICC-ES evaluation report.
 - 3. Manufacturer's certificate that product meets requirements of specification.
 - 4. Preparation instructions and recommendations.
 - 5. Storage and handling requirements and recommendations.
 - 6. Installation methods.
- D. Shop Drawings: Engineering drawings for installation, including elevations, large-scale details of elevations, typical sections, details, and connections, soil reinforcement, and drainage provisions.
 - 1. Include marked up contract drawings showing exact dimensions for blocks, required coping, and other minor revisions.
 - 2. Design Data: Submit detailed design calculations showing compliance with specified design criteria and material evaluations performed in accordance with specified design standard, signed and sealed by Design Engineer.
- E. Product Certification: Provide with each shipment indicating that specified materials have been delivered.
- F. Unit Sample for Selection: Minimum 3 inch (75 mm) square pieces of actual units showing colors and finish textures available.
- G. Unit Sample: One unit units typical of size, color, and finish texture specified.

- H. Soil Reinforcement Sample: Two pieces of each specified type, labeled, 12 by 12 inches (305 by 305 mm).
- I. Soil Reinforcement to Unit Connector: One connector.
- J. Preconstruction Soil Test Reports.
- K. Design Engineer's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Design Engineer Qualifications: Provide design by or under direct supervision of Professional Engineer experienced in the work of this section and licensed in the State in which the Project is located and:
 - 1. Having minimum of five years documented experience in design of reinforced soil structures.
 - 2. Employed by firm that has designed a minimum of 500,000 square feet (46,450 sq m) of segmental retaining walls.
 - 3. Having minimum of \$2,000,000 aggregate liability insurance.
- B. Geotechnical Engineer: Employed by Owner; licensed in the State in which the Project is located.

1.06 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty for Segmental Retaining Wall.

PART 2 PRODUCTS

2.01 RETAINING WALLS

- A. Contractor is responsible for design of the retaining walls.
- B. Architect has designed the retaining walls; provide products and installation as indicated in Contract Documents.
- C. Architect has designed the retaining walls; alternative solutions will be considered provided Contractor provides complete engineering design at no extra cost to Owner.
 - 1. Shop drawing submittal is required only for approved alternative solutions.
- Design Standard: Design retaining walls to be capable of withstanding the effects of gravity loads due to soil pressures resulting from grades indicated, determined in accordance with:
 NCMA TR-127.
 - 2. FHWA NHI-10-024 and FHWA NHI-10-025.
 - 3. In addition, comply with applicable local, state, and federal codes and regulations.
 - 4. This design method considers potential failure modes categorized by external, internal, local, compound, and global stability.
 - 5. Provide engineering services as required for analysis for all modes of stability.
 - 6. Use of design software for calculations is permitted.
 - 7. Submit complete shop drawings showing all features of the design.
- E. Batter Ratio: Between 1 horizontal in 16 vertical and 1 horizontal to 6 vertical.
- F. Setback: 1/8 inch (3 mm) back from face per course.
- G. Mass (Weight) Per Wall Face Area: 35 pounds per square foot (171 kg per sq m), minimum, including filled voids.
- H. Shear Resistance: Design the wall not to exceed the capacity of materials and soils to resist shear:
 - 1. Shear Resistance Between Units: Determine in accordance with ASTM D6916.
 - 2. Connection Between Units and Soil Reinforcement: Determine in accordance with ASTM D6638. Strength shall exceed the maximum tensile force with a Factor of Safety of 1.5.

- 3. Coefficient for Direct Shear of Reinforcement on Soil: Determine in accordance with ASTM D5321/D5321M using soil similar in gradation and texture to that to be used for fill in the reinforced zone.
- I. Soil Reinforcement:
 - 1. Test reinforcement to be used in accordance with ASTM D6706 using soil taken from project site.
 - 2. Do not use more than one type of reinforcement attached to units within the same wall; do not use products made by different manufacturers in the same wall; minimize the number of different reinforcement and filter products to avoid confusion in placement.
 - 3. Walls Less Than 12 feet (3.5 m) High: Use only one type of reinforcement of one grade and strength.
 - 4. Length Back from Wall: Not less than dimensions shown on drawings.
 - 5. Long Term Design Strength of Reinforcement: LTDS = Tult / (RFd x RFid x RFcr), where:
 - a. Tult = Ultimate (tensile) strength per ASTM D4595.
 - b. RFd = Reduction Factor for chemical and biological durability; minimum 2.0 if durability testing has not been conducted, otherwise 1.1 for High-density polyethylene. (HDPE), and 1.1 for polyethylene terephthalate (PET).
 - c. RFid = Reduction Factor for Installation Damage; minimum 1.1 and 3.0 if testing per ASTM D5818 has not been conducted.
 - d. RFcr = Reduction Factor for Creep; consistent with test procedure used for determining the ultimate strength per ASTM D5262.
 - e. The product RFd x RFid x RFcr shall be greater than 2.0.
- J. Drainage: Design to prevent water accumulation in retained soil; use drainage fill and drainage pipe as specified in Section 334100; provide outlets at 50 foot (15 m) intervals along length of wall, minimum.
- K. Minimum Factor of Safety: Design with the following stability requirements:
 - 1. Sliding = 1.5.
 - 2. Pullout = 1.5.
 - 3. Tensile Overstress = 1.5.
 - 4. Overturning = 2.0.
 - 5. Bearing Capacity = 2.0.

2.02 MATERIALS

- A. Retaining Wall Units: Machine-formed concrete blocks of shapes and sizes suitable for the retaining wall configuration required and complying with ASTM C1372 and the following:
 - 1. Portland Cement: Type I in accordance with ASTM C150/C150M.
 - 2. Face Color: Natural cement gray.
 - 3. Texture: Split face, on exposed surfaces.
 - 4. Face Shape: Straight (flat).
 - 5. Curved Walls: Provide unit shapes that accommodate the required curves without cutting and with gaps between faces of adjacent units of not more than 1/8 inch (3 mm) and a minimum radius of 3 1/2 feet (1 m).
 - 6. Acute Corners: Provide special shapes to form corners without cutting; exposed faces finished to match.
 - 7. Unit Face Area: 2/3 square feet (0.06 sq m), minimum.
 - 8. Height: 4 inches (102 mm), minimum.
 - 9. Length (Face Width): 8 inches (203 mm), minimum.
 - 10. Width (Depth from Face): 11 inches (279 mm), minimum, not including textured finish.
 - 11. Face Wall Thickness: 2 inches (51 mm), minimum.
 - 12. Batter Ratio: Between 1 horizontal in 16 vertical and 1 horizontal to 6 vertical.
 - 13. Batter Dimensional Control: Provide integral positive control to maintain consistent batter dimension.
 - 14. Shear Resistance Mechanism: Manufacturer's standard.
 - 15. Moisture Absorption: 8 percent, maximum.

- 16. Freeze-Thaw Resistance: Maximum of 1 percent or less weight loss after 100 cycles for each of 5 specimens or maximum of 1.5 percent or less weight loss after 150 cycles for 4 of 5 specimens, when tested in accordance with ASTM C1262/C1262M.
- 17. Compressive Strength, 28 Day: 3000 pounds per square inch (20.7 MPa), minimum in accordance with ASTM C140/C140M.
- 18. Concrete Density: 125 pounds per cubic foot (2000 kg per cubic m), minimum, oven dry.
- B. Cap Units: Portland cement concrete machine-formed solid blocks, matching segmental retaining wall units, complying with ASTM C1372, with abutting edges saw cut or formed to provide tight fitting, flush end-to-end joints.
 - 1. Height: 4 inches (102 mm), minimum.
 - 2. Width: Same as wall units.
 - 3. Depth: To fully cover wall units.
 - 4. Masonry Adhesive: To secure cap units as top course of wall.
 - a. Expected Life Span: 30 years.
 - b. Provide adhesive complying with ASTM C920, Type S, Grade NS, Class 25, and as approved by unit manufacturer.
- C. Shear Connectors: Connection method to withstand design stresses and prevent movement of segmental retaining wall units, and to hold soil reinforcement in proper design position during grid pre-tensioning and backfilling.
 - 1. Flexural Strength: 128,000 pounds per square inch (882 MPa), minimum, determined in accordance with ASTM D6638.
 - 2. Short Beam Shear: 6,400 pounds per square inch (44 MPa), minimum, determined in accordance with ASTM D6638.
 - 3. Maintain strength over design temperature range of minus 10 degrees F (23 degrees C) to plus 100 degrees F (38 degrees C).
- D. Soil Reinforcement: Polymeric geosynthetic specifically fabricated to interlock with surrounding soil, rock, or earth for use as reinforcement, dimensionally stable and able to retain geometry under manufacture, transport, and installation.
 - 1. Polymeric Material: 100 percent virgin resin with maximum of 5 percent in-plant regrind material; polypropylene, polyethylene, or polyester.
 - a. Polyethylene and Polypropylene: Stabilized with long term antioxidants.
 - b. Polyester: Minimum molecular weight of 25,000 and carboxyl end group number less than 30.
 - 2. Construction: Woven.
 - 3. Long Term Design Strength: minimum average roll value in machine direction, tested in accordance with NCMA TR-127.
 - 4. Ultimate Tensile Strength: tested in accordance with NCMA TR-127.
 - 5. Permittivity: 0.5 per second, minimum, when tested in accordance with ASTM D4491/D4491M.
 - 6. UV Resistance: 70 percent after 500 hours, when tested in accordance with ASTM D4355/D4355M.
 - 7. Durability: Comply with minimum requirements of AASHTO M 288 Class 1; minimum mass of 8 ounces per square yard (270 g/sq m).
- E. Drainage Filter: Geosynthetic textile.
 - 1. Tensile Strength (Grab) Woven: 250 pounds (1100 N), when tested in accordance with ASTM D4632/D4632M.
 - 2. Tensile Strength (Grab) Non-Woven: 160 pounds (700 N), when tested in accordance with ASTM D4632/D4632M.
 - 3. Apparent Opening Size: 70 to 100 U.S. Sieve size (150 to 212 micrometer), when tested in accordance with ASTM D4751.
 - 4. Permittivity: 0.5 per second, minimum, when tested in accordance with ASTM D4491/D4491M.
 - 5. Durability: Comply with minimum requirements of AASHTO M 288 Class 1; minimum mass of 8 ounces per square yard (270 g/sq m).

- F. Aggregate for Leveling Pad: Compacted sand, gravel, or crushed rock complying with one of the following:
 - 1. As specified in Section 312323.
 - 2. Meeting requirements of ASTM D1241, Gradation C.
 - 3. Do not use pea gravel.
- G. Concrete for Leveling Pad: Unreinforced concrete with compressive strength of 3,000 pounds per square inch (20 MPa).
- H. Drainage Fill: Clean, freely draining aggregate placed within, between, or immediately behind segmental retaining wall units; do not use pea gravel; use one of the following:
 - 1. Aggregate as approved by Architect.
 - 2. Aggregate meeting requirements of ASTM D448, Size No. 57.
 - 3. Crushed stone or coarse gravel, 3/8 inch (10 mm); no more than 5 percent passing No. 200 sieve.
 - 4. Crushed stone or coarse gravel, meeting requirements of ASTM D7928.
 - a. Sieve Size 1 inch (25 mm): 100 percent passing.
 - b. Sieve Size 3/4 inch (19 mm): 75 to 100 percent passing.
 - c. Sieve Size No. 4: 0 to 60 percent passing.
 - d. Sieve Size No. 40: 0 to 50 percent passing.
 - e. Sieve Size No. 200: 0 to 5 percent passing.
- I. Reinforced Backfill: Compacted soil placed behind drainage fill within reinforced soil mass; do not use heavy clay or organic soils; comply with one of the following:
 - 1. Use site-excavated or other soil approved by Architect.
 - 2. Granular soil with less than 35 percent passing No. 200 sieve per ASTM D7928.
 - 3. Inorganic ASTM D2487 soil types GP, GW, SP, or SM, free of debris.
 - a. Maximum Size: 3/4 inch (19 mm), unless approved by Design Engineer, and design strength reduced to account for additional installation damage.
 - b. Plasticity of Fines: Less than 10. Liquid Limit: Less than 40, when tested in accordance with ASTM D4318.
 - c. Maximum Dry Unit Weight: Greater than or equal to 100 pounds per cubic foot (16 kg/cm) per ASTM D698.
 - d. Internal Angle of Friction: Equal to 30 degrees per ASTM D2166/D2166M.
 - e. Sieve Size 4 inches (102 mm): 75 to 100 percent passing.
 - f. Sieve Size 1 inch (25 mm): 75 to 100 percent passing.
 - g. Sieve Size No. 4: 20 to 100 percent passing.
 - h. Sieve Size No. 40: 0 to 60 percent passing.
 - i. Sieve Size No. 200: 0 to 35 percent passing.
- J. Drainage Pipe: 4 inch (100 mm) Perforated schedule 40 PVC, complying with ASTM D3034; or corrugated HDPE complying with ASTM F405; with geotextile filter wrap.

PART 3 EXECUTION

3.01 PREPARATION

- A. Sitework:
- B. Excavation:
 - 1. Excavate to lines and grades indicated on drawings.
 - Do not disturb embankment or foundation beyond lines. Minimize over-excavation; fill over-excavated areas with compacted reinforced backfill or leveling pad material at Contractor's expense.
 - After excavation, and prior to placement of leveling materials, Geotechnical Engineer will examine bearing soil surface to verify strength meets or exceeds design requirements and assumptions.
 - 4. Replace unsuitable bearing soil as directed by Architect.
- C. Leveling Pad:
 - 1. Width: 6 inches (152 mm) minimum extension beyond front and back faces of units.

- 2. In lieu of pad made solely of aggregate or concrete, pad may be 3 inches (75 mm), minimum, of thick compacted sand or crushed rock, covered with 2 inches (50 mm) to 3 inches (75 mm) of unreinforced concrete.
- 3. Location: Top of pad at 1 inch (25 mm) below grade for each 8 inches (200 mm) that wall extends above grade.
- 4. Compact aggregate to lines and grades on drawings, in lifts 6 inches (152 mm) thick, maximum.
- 5. Use only hand-operated compaction equipment within 36 inches (1 m) of back of wall.
- D. Verify level grade before proceeding.
- E. Install drainage collection pipe with a continuous fall in the direction of flow. Cap open ends as necessary to prevent soil and debris from entering.

3.02 INSTALLATION

- A. Install in accordance with drawings, manufacturer instructions, and applicable codes and regulations.
- B. Segmental Retaining Wall Units:
 - 1. Place first course of units on leveling pad; check alignment and level. Check for full contact with base and for stability.
 - 2. Place units side by side for full length of wall, aligning back face of straight walls using string line or offset from base line and back face of curved walls using flexible pipe or other method recommended by manufacturer.
 - 3. Do not leave gaps between units.
 - 4. Lay out corners and curves in accordance with manufacturer's instructions. Do not leave gaps to produce wall batter or curvature.
 - 5. Cut blocks with saw; do not split units.
 - 6. Sweep excess material from tops of units before laying succeeding courses.
 - 7. Place a maximum of 2 succeeding courses above level backfill. Check for proper alignment and batter.
 - 8. Where top of wall changes elevation, step units to match grade or turn top course into embankment.
 - 9. Where bottom of wall changes elevation, step base leveling pad and extend lowest course a minimum of two units into slope.
 - 10. Install shear connectors per manufacturer recommendations.
- C. Soil Reinforcement: Install each layer on fully compacted fill.
 - 1. Orient soil reinforcement material with highest strength axis perpendicular to wall alignment.
 - 2. Attach to top of wall units and extend horizontally, full length, over compacted backfill slightly sloping downward away from wall.
 - 3. Install in one piece lengths with 100 percent coverage in each layer at each level. Do not splice or leave gaps between panels or ends of pieces.
 - 4. Pull taut and remove slack prior to backfill placement.
- D. Drainage Fill: Place drainage fill in, between, and behind units.
 - 1. Compact to lines and grades on drawings, in lifts 6 inches (152 mm) thick, maximum; decrease lift thickness where necessary to achieve required density.
 - 2. Extend drainage fill 6 inches (150 mm) beyond back face of units.
 - 3. Base of drainage fill elevation shall not exceed two courses or 16 inches (400 mm) from base of wall units.
- E. Backfill: Place, spread, and compact backfill from behind drainage fill to undisturbed soil while minimizing the development of slack in the soil reinforcement.
 - 1. Use only lightweight hand-operated compaction equipment within 3 feet (900 mm) from back wall face, or one half of wall height, whichever is greater.
 - 2. Place backfill in lifts of maximum 6 inches (150 mm) to 8 inches (200 mm) loose thickness where hand compaction is used and 8 inches (200 mm) to 10 inches (250 mm) where heavy compaction equipment is used.

- 3. Compact backfill to 95 percent maximum density and upper 2 feet (600 mm) of backfill to 98 percent maximum density, standard Proctor, as determined in accordance with ASTM D698, or as recommended by Geotechnical Engineer.
- 4. Moisture content of backfill prior to and during compaction to be within plus or minus 2 percentage points dry of optimum and uniform throughout each layer.
- 5. Do not operate tracked construction equipment directly upon soil reinforcement. Maintain a minimum fill thickness of 6 inches (150 mm) for operation of tracked vehicles over soil reinforcement. Minimize turning of tracked vehicles while over soil reinforcement.
- 6. Operate wheeled equipment at speeds less than 10 miles per hour (16 kph) over soil reinforcement.
- 7. Prevent contamination of the filter fabric, unit fill, blanket drains, chimney drains, and/or drainage composite from poor drainage materials such as fine grained silt and clay.
- F. Cap Units: Install and top two courses of units with masonry adhesive.
 - 1. Verify in-place top of wall elevation prior to installation of cap units and adjust accordingly.
 - 2. Clear cap units and top course of segmental retaining wall units of debris and standing water before applying adhesive.
 - 3. Apply masonry adhesive to top surface of top unit and place cap into position over projecting pins. Protect wall face from masonry adhesive.
- G. Site Drainage:
 - 1. At end of each day:
 - a. Grade backfill a minimum of 2 percent away from wall to prevent runoff from adjacent areas from entering wall site and to prevent ponding at the wall.
 - b. Construct a berm at the crest of the wall to prevent surface water from overtopping.
 - 2. At completion, if other work adjacent to wall is not to be done immediately (paving, landscaping, etc), grade top of backfill and provide temporary drainage to prevent water runoff toward the wall.
 - 3. Surface water control and groundwater seepage shall be the responsibility of the project Architect.

3.03 PROTECTION

- A. Prevent damage to wall and earthwork by subsequent construction and uncontrolled runoff until substantial completion; repair damage due to failure to protect wall or earthwork.
- B. Do not operate equipment with wheel loads in excess of 150 pounds per square foot (1000 kPa) live load within 10 feet (3 m) from the wall face.
- C. Do not place temporary soil or fill stockpiles adjacent to wall.

SECTION 329219 SEEDING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 312200 Grading: Topsoil material.
- B. Section 312323 Fill: Topsoil material.

1.02 SUBMITTALS

- A. Topsoil samples.
- B. Certificate: Certify seed mixture approval by authority having jurisdiction.
- C. Maintenance Contract.

PART 2 PRODUCTS

2.01 SEED MIXTURE

A. Seed Mixture:

2.02 SOIL MATERIALS

- A. Topsoil: as specified in Section 312200.
- B. Topsoil: as specified in Section 312323.
- C. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.
- D. Topsoil: Excavated from site and free of weeds.

2.03 ACCESSORIES

- A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- B. Mulching Material: Thermally refined wood fiber, nontoxic, free of growth or germination inhibiting ingredients, dust form.
- C. Fertilizer: Recommended for grass, slow release nitrogen, biological materials, and biostimulant materials; of proportion necessary to eliminate deficiencies of topsoil.
- D. Fertilizer: Recommended for grass, with 50 percent of the elements derived from organic sources; of proportion necessary to eliminate deficiencies of topsoil, to the following proportions:
- E. Soil pH Neutralizer: Recommended for planting and re-vegetating areas with acidic soils, as indicated by analysis.
- F. Biostimulant: Recommended to accelerate vegetation establishment.
- G. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- H. Erosion Fabric: Jute matting, open weave.
- I. Stakes: Softwood lumber, chisel pointed.
- J. String: Inorganic fiber.
- K. Edging: Galvanized steel.

PART 3 EXECUTION

3.01 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

- D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.02 SOIL NEUTRALIZER

- A. Apply in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply soil neutralizer at same time or with same machine used to apply seed.
- D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- E. Lightly water to aid dissipation.

3.03 SEEDING

- A. Apply seed evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.
- E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.
- F. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.04 HYDROSEEDING

- A. Apply seeded slurry with a hydraulic seeder evenly in two intersecting directions.
- B. Do not hydroseed area in excess of that which can be mulched on same day.
- C. Immediately following seeding, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.
- D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.
- E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.05 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
- B. See Section 017000 Execution Requirements, for additional requirements relating to maintenance service.
- C. Provide a separate maintenance contract for specified maintenance service.
- D. Provide maintenance of seeded areas for three months from Date of Substantial Completion.
- E. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- F. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches (65 mm). Do not cut more than 1/3 of grass blade at any one mowing.
- G. Neatly trim edges and hand clip where necessary.
- H. Immediately remove clippings after mowing and trimming.
- I. Water to prevent grass and soil from drying out.
- J. Roll surface to remove minor depressions or irregularities.
- K. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- L. Immediately reseed areas that show bare spots.

M. Protect seeded areas with warning signs during maintenance period.

SECTION 329223 SODDING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding 2006.

1.02 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Certificate: Certify grass species and location of sod source.
- C. Certificate: Certify fertilizer and herbicide mixture approval by authority having jurisdiction.
- D. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type indicated in plant schedule on Drawings; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft (100 sq m). Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
 - 1. St. Augustine Grass Type
 - 2. Floratam Grass Type
 - 3. Kentucky Blue Grass Type
 - 4. Thickness: "Thin" sod, minimum 1/2 inch (13 mm) and maximum 1 inch (25 mm) topsoil base.
 - 5. Thickness: "Thick" sod, minimum 1 inch (25 mm) and maximum 1-3/8 inch (35 mm) topsoil base.
 - 6. Cut sod in area not exceeding 1 sq yd (1 sq m).
 - 7. Machine cut sod and load on pallets in accordance with TPI (SPEC) Guidelines.
- B. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay, or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.
- C. Topsoil: Excavated from site and free of weeds.
- D. Fertilizer: recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.

PART 3 EXECUTION

3.01 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to installation of sod.
- C. Apply fertilizer no more than 48 hours before laying sod.
- D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.02 LAYING SOD

- A. Moisten prepared surface immediately prior to laying sod.
- B. Lay sod immediately after delivery to site to prevent deterioration.
- C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches (300 mm) minimum. Do not stretch or overlap sod pieces.
- D. Water sodded areas immediately after installation. Saturate sod to 4 inches (100 mm) of soil.

E. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

SECTION 329300 PLANTS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 312200 - Grading: Topsoil material.

1.02 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Certificate: Certify fertilizer and herbicide mixture approval by authority having jurisdiction.
- C. Certificate: Submit certificate for plants free of disease or hazardous insects; certified by federal department of agriculture; free of disease or hazardous insects.
- D. Maintenance Data: Include cutting and trimming method ; types, application frequency, and recommended coverage of fertilizer .
- E. Submit list of plant life sources.
- F. Maintenance Contract.

1.03 FIELD CONDITIONS

- Do not install plant life when ambient temperatures may drop below 35 degrees F (2 degrees C) or rise above 90 degrees F (32 degrees C).
- B. Do not install plant life when wind velocity exceeds 30 mph (48 k/hr).

1.04 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide one year warranty.
- C. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.
- D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.01 PLANTS

A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

2.02 SOIL MATERIALS

- A. Topsoil: as specified in Section 312200.
- B. Topsoil: Excavated from site.
- C. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0.

2.03 SOIL AMENDMENT MATERIALS

- A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
 - 1. Nitrogen
 - 2. Phosphoric Acid
 - 3. Soluble Potash
- B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.
- C. Bone Meal: Raw, finely ground, commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.

- D. Lime: Ground limestone, dolomite type, minimum 95 percent carbonates.
- E. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.
- F. Herbicide
- G. Pesticide

2.04 MULCH MATERIALS

- A. Mulching Material: species wood shavings, free of growth or germination inhibiting ingredients.
- B. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

2.05 ACCESSORIES

- A. Wrapping Materials: Burlap.
- B. Stakes: Softwood lumber, pointed end.
- C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.
- D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.
- E. Grates: Cast iron, galvanized finish, with grillage design, sized to resist pedestrian loads.
- F. Decorative Cover: Fir bark chips
- G. Membrane: 20 mil (0.5 mm) thick, clear polyethylene.
- H. Wrapping: Waterproof fabric.
- I. Tree Protectors: Metal with galvanized rings.
- J. Tree Grate: 2 inches (51 mm) thick, height equal to slab thickness.
 - 1. Material: Ductile iron.
 - 2. Shape: Square.
 - 3. Length/Width: 4 feet (1.2 m).
 - 4. Style: Grid.
 - 5. Color: Black.

2.06 TOP SOIL MIX

A. A uniform mixture of 1 part peat and 3 parts topsoil by volume.

PART 3 EXECUTION

3.01 PLACING TOPSOIL

- A. Spread topsoil to a minimum depth of 4 inches (100 mm) over area to be planted. Rake smooth.
- B. Place topsoil during dry weather and on dry unfrozen subgrade.
- C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
- D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
- E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches (150 mm).

3.02 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after initial raking of topsoil.
- C. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- D. Lightly water to aid the dissipation of fertilizer.

3.03 PLANTING

A. Place plants for best appearance.

- B. Place plants for best appearance for review and final orientation by Architect.
- C. Set plants vertical.
- D. Remove non-biodegradable root containers.
- E. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches (of 150 mm) under each plant. Remove burlap, ropes, and wires, from the root ball.
- F. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch (150 mm) layers. Maintain plant life in vertical position.
- G. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.04 INSTALLATION OF ACCESSORIES

- A. Place decorative cover and membrane, where indicated on drawings.
- B. Place grates at base of trees where indicated on drawings.

3.05 PLANT SUPPORT

- A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:
 - 1. Tree Caliper: 1 inch (25 mm); Tree Support Method: 1 stake with one tie
 - 2. Tree Caliper: 1 to 2 inches (25 to 50 mm); Tree Support Method: 2 stakes with two ties
 - 3. Tree Caliper: 2 to 4 inches (50 to 100 mm); Tree Support Method: 3 guy wires with eye bolts and turn buckles
 - 4. Tree Caliper: Over 4 inches (100 mm); Tree Support Method: 4 guy wires with eye bolts and turn buckles

3.06 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Maintain plant life for three months after Date of Substantial Completion.
- D. Maintain plant life immediately after placement and until plants are well established and exhibit a vigorous growing condition. Continue maintenance until termination of warranty period.
- E. Irrigate sufficiently to saturate root system and prevent soil from drying out.
- F. Remove dead or broken branches and treat pruned areas or other wounds.
- G. Neatly trim plants where necessary.
- H. Immediately remove clippings after trimming.
- I. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions.
- J. Control insect damage and disease. Apply pesticides in accordance with manufacturers instructions.
- K. Remedy damage from use of herbicides and pesticides.
- L. Replace mulch when deteriorated.
- M. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

SECTION 330110.58 DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Disinfection of site domestic water lines and site fire water lines specified in Section 331416.

1.02 RELATED REQUIREMENTS

A. Section 331416 - Site Water Utility Distribution Piping.

1.03 REFERENCE STANDARDS

- A. AWWA B300 Hypochlorites 2018.
- B. AWWA B301 Liquid Chlorine 2018.
- C. AWWA B302 Ammonium Sulfate 2016.
- D. AWWA B303 Sodium Chlorite 2018.
- E. AWWA C651 Disinfecting Water Mains 2014, with Addendum (2020).

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Certificate: From authority having jurisdiction indicating approval of water system.
- D. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.
- E. Disinfection report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start and time of completion.
 - 3. Test locations.
 - 4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - 5. Date and time of flushing start and completion.
 - 6. Disinfectant residual after flushing in ppm for each outlet tested.
- F. Bacteriological report:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.
 - 3. Name of person collecting samples.
 - 4. Test locations.
 - 5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 - 6. Coliform bacteria test results for each outlet tested.
 - 7. Certification that water complies, or fails to comply, with bacterial standards.

PART 2 PRODUCTS

2.01 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300 Hypochlorite, AWWA B301 Liquid Chlorine, AWWA B302 Ammonium Sulfate, and AWWA B303 Sodium Chlorite.

PART 3 EXECUTION

3.01 DISINFECTION

- A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.
- B. Provide and attach equipment required to perform the work.
- C. Inject treatment disinfectant into piping system.
- D. Maintain disinfectant in system for 24 hours.

- E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
- F. Replace permanent system devices removed for disinfection.

3.02 FIELD QUALITY CONTROL

A. Test samples in accordance with AWWA C651.

SECTION 330561 CONCRETE MANHOLES

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Allowances:
 - 1. See Section 012100 Allowances for allowances affecting this section.
- B. Unit Prices: Concrete Manholes
 - 1. See Section 012200 Unit Prices, for additional unit price requirements.
 - 2. Basis of Measurement: By the unit for a nominal depth.
 - 3. Basis of Payment: Includes excavation, hand trimming, bedding and backfilling, base pad, frame and grate, accessories.
- C. Alternates:
 - 1. See Section 012300 Alternates for product alternates affecting this section.

1.03 REFERENCE STANDARDS

- A. AASHTO HB Standard Specifications for Highway Bridges 2005, with Errata.
- B. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- C. ACI 440.1R Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars 2015, with Errata (2020).
- D. ASTM A48/A48M Standard Specification for Gray Iron Castings 2022.
- E. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- F. ASTM C33/C33M Standard Specification for Concrete Aggregates 2018.
- G. ASTM C55 Standard Specification for Concrete Building Brick 2017.
- H. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete 2022a.
- I. ASTM C139 Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes 2017.
- J. ASTM C150/C150M Standard Specification for Portland Cement 2022.
- K. ASTM C270 Standard Specification for Mortar for Unit Masonry 2019a, with Editorial Revision.
- L. ASTM C478/C478M Standard Specification for Circular Precast Reinforced Concrete Manhole Sections 2020.
- M. ASTM C990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants 2009 (Reapproved 2019).
- N. ASTM C1634 Standard Specification for Concrete Facing Brick and Other Concrete Masonry Facing Units 2020.
- O. ASTM D6783 Standard Specification for Polymer Concrete Pipe 2005a (Reapproved 2017).
- P. TMS 402/602 Building Code Requirements and Specification for Masonry Structures 2022.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.
- C. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.
- D. Manufacturer's Installation Instructions: Indicate special procedures for assembly.

- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- H. Field Quality Control Submittals: Document results of field quality control testing.
- I. Project Record Documents:
 - 1. Record invert elevations of concrete manholes.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.05 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 CONCRETE MANHOLES

- A. Weight Rating: H 10 according to AASHTO HB.
- B. Precast Concrete Manholes: Comply with ASTM C478/C478M, reinforced.
 - 1. Wall Thickness: 6 inches (152 mm).
 - 2. Base Thickness: 12 inches (305 mm).
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 4. Joint Sealant: Comply with ASTM C990.
- C. Concrete Masonry Unit Manholes: Comply with ASTM C139, reinforced.
 - 1. Concrete Blocks: Curved, solid.
 - 2. Mortar: Type M, in accordance with ASTM C270.
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
- D. Cast-In-Place Concrete Manholes: Comply with ASTM C94/C94M, reinforced.
 - 1. Wall Thickness: 6 inches (152 mm).
- E. Cast-In-Place Concrete Base Pads: Comply with ASTM C94/C94M, reinforced.
 - 1. Thickness: 12 inches (305 mm).
 - 2. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 3. Width: Match outside catch basin diameter.
- F. Cast-In-Place Concrete Materials: See Section 033000.
- G. Cast-In-Place Concrete Materials:
 - 1. Cement: ASTM C150/C150M, Type II.
 - 2. Sand: ASTM C33/C33M, fine aggregate.
 - 3. Crushed Gravel: ASTM C33/C33M, coarse aggregate.
 - 4. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 5. Water: Potable.
- H. Polymer Concrete Manholes: Comply with ASTM D6783, reinforced.
 - 1. Wall Thickness: 6 inches (152 mm).
 - 2. Base Thickness: 6 inches (152 mm).
 - 3. Reinforcement: Fiber-reinforced polymer bars, in accordance with ACI 440.1R.
 - 4. Joint Sealant: Comply with ASTM C990.
- I. Polymer Concrete Manhole Inserts: Comply with ASTM D6783, reinforced.
 - 1. Wall Thickness: 7 inches (178 mm).
 - 2. Base Thickness: 6 inches (152 mm).
 - 3. Reinforcement: Fiber-reinforced polymer bars, in accordance with ACI 440.1R.

- 4. Joint Sealant: Comply with ASTM C990.
- J. Polymer Mortar: Provided by the manufacturer.
- K. Grade Adjustments:
 - 1. Concrete Bricks: ASTM C1634 or ASTM C55 Grade N, cored, normal weight.
- L. Mortar Mixing:
 - 1. Ready Mixed Mortar: Type equivalent to that specified according to ASTM C270.
 - 2. Thoroughly mix mortar ingredients in accordance with ASTM C270 and in quantities needed for immediate use.
 - 3. Maintain sand uniformly damp immediately before the mixing process.
 - 4. Do not use antifreeze compounds to lower the freezing point of mortar.
 - 5. Waterproofing Admixture: Surface applied.
 - 6. Microbiologically-Induced Corrosion-Inhibiting Admixture: Resists growth of bacteria and fungi on or inside concrete.
 - 7. If water is lost by evaporation, retemper only within two hours of mixing.
- M. Frame and Cover: Cast iron construction, ASTM A48/A48M Class 30B, machined flat bearing surface; hinged; sealing gasket.

2.02 ACCESSORIES

- A. Steps: Formed galvanized steel rungs; 3/4 inch (19 mm) diameter. Formed integral with manhole sections.
- B. Strap Anchors: Bent steel shape, galvanized to ASTM A123/A123M Grade specified for applicable material category.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.
- B. Precast Concrete Manholes:
 - 1. Place base section plumb and level.
 - 2. Install joint sealant uniformly around section lip.
- C. Cast-In-Place Concrete Base Pad:
 - 1. Form bottom of excavation walls clean and smooth to correct limits.
 - 2. Install reinforcement in maximum lengths. Offset end laps in both directions. Splice laps with tie wire.
 - 3. Place concrete in accordance with ACI 304R.
 - 4. Float base pad top surface level.
- D. Concrete Masonry Unit Manholes:
 - 1. Place full mortar bed on concrete base pad.
 - 2. Lay masonry units plumb on mortar with full head joints and uniform concave vertical joints.
 - 3. Maintain level running bond courses with uniform concave horizontal joints.
 - 4. Install joint reinforcement 16 inches (400 mm) on center.
 - 5. Taper diameter to opening in four courses.
- E. Cast-In-Place Concrete Manholes:
 - 1. Form catch basin on concrete base pad plumb and level.
 - 2. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
 - 3. Install reinforcement in maximum lengths. Offset end laps in both directions. Splice laps with tie wire.
 - 4. Place concrete in accordance with ACI 304R.
 - 5. Float catch basin top surface level.
- F. Polymer Concrete Manholes: Install according to manufacturer's instructions.
- G. Polymer Concrete Manhole Inserts: Install according to manufacturer's instructions.

- H. Grade Adjustments:
 - 1. Lay brick or masonry units uniformly on mortar bed with full head joints, running bond. Top with mortar, plumb and level.
 - 2. Place adjacent materials tight, and smooth following design grades.
- I. Frames and Covers:
 - 1. Place frame plumb and level.
 - 2. Mount frame on mortar bed at indicated elevation.
 - 3. Place grate in frame securely.

SECTION 331416 SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete: Concrete for thrust restraints.
- B. Section 099113 Exterior Painting.
- C. Section 211100 Facility Fire-Suppression Water-Service Piping.
- D. Section 330561 Concrete Manholes.

1.02 REFERENCE STANDARDS

- A. AASHTO HB Standard Specifications for Highway Bridges 2005, with Errata.
- B. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
- C. ASME B16.4 Gray Iron Threaded Fittings: Classes 125 and 250 2021.
- D. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- E. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- F. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- G. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- H. ASTM A563/A563M Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric) 2021a.
- I. ASTM B88 Standard Specification for Seamless Copper Water Tube 2022.
- J. ASTM D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2021a.
- K. ASTM D2466 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2021.
- L. ASTM D2467 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2020.
- M. ASTM D2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.
- N. ASTM D3035 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter 2022.
- O. ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals 2019.
- P. ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing 2022.
- Q. AWS A5.8M/A5.8 Specification for Filler Metals for Brazing and Braze Welding 2019.
- R. AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems 2018.
- S. AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.
- T. AWWA C115/A21.15 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges 2020.
- U. AWWA C200 Steel Water Pipe, 6 In. (150 mm) and Larger 2017.
- V. AWWA C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipe 2020.
- W. AWWA C205 Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. (100 mm) and Larger—Shop Applied 2018.

- X. AWWA C206 Field Welding of Steel Water Pipe 2017.
- Y. AWWA C207 Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm) 2018.
- Z. AWWA C208 Dimensions for Fabricated Steel Water Pipe Fittings 2017.
- AA. AWWA C210 Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings 2015, with Addendum (2020).
- BB. AWWA C500 Metal-Seated Gate Valves for Water Supply Service 2019.
- CC. AWWA C502 Dry-Barrel Fire Hydrants 2018.
- DD. AWWA C504 Rubber-Seated Butterfly Valves 2015.
- EE. AWWA C508 Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS 2017.
- FF. AWWA C509 Resilient-Seated Gate Valves for Water Supply Service 2015.
- GG. AWWA C600 Installation of Ductile-Iron Mains and Their Appurtenances 2017.
- HH. AWWA C602 Cement-Mortar Lining of Water Pipelines in Place 4 In. (100 mm) and Larger 2017.
- II. AWWA C606 Grooved and Shouldered Joints 2015.
- JJ. AWWA C800 Underground Service Line Valves and Fittings 2021.
- KK. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm) 2016, with Errata (2018).
- LL. AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service 2020.
- MM. AWWA C904 Cross-Linked Polyethylene (PEX) Pressure Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service 2016.
- NN. AWWA M11 Steel Pipe A Guide for Design and Installation 2016, with Addendum (2019).
- OO. UL 246 Hydrants for Fire-Protection Service Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.04 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 WATER PIPE

- A. Steel Pipe: Welded or Seamless complying with AWWA C200.
 - 1. Underground Pipe and Fittings: Cement-mortar lining and cement-mortar coating.
 - 2. Aboveground Pipe and Fittings: Cement-mortar lining.
 - 3. Fittings: AWWA C208.
 - a. Construct of same material as pipe with standard tube turns or segmentally welded sections to accommodate the type of couplings or joints provided.
 - b. Thickness Rating: Comply with not less than specified pipe thickness and calculated pipe pressure rating.
 - c. Mechanically or manually wrap, line, and coat all fittings with same protective materials and applications used for pipe.

- 4. Pipe manufacturer to calculate and determine wall thickness and fittings in the following manner:
 - a. Design Parameters:
 - 1) Water Hammer: 40 percent of pressure rating.
 - 2) Live Load: H20 truck loading in accordance with AASHTO HB.
 - 3) Allowable Deflection: 2 percent of nominal pipe diameter.
 - 4) Modulus of Soil Reaction (E'): pipe manufacturer values.
 - b. Calculate pipe wall thickness on the basis of an allowable fiber stress in the steel equal to 50 percent of the minimum yield strength of the steel used in the manufacture of the pipe.
 - c. Comply with design procedures outlined in AWWA M11.
- 5. Joints:
 - a. Rubber Gasketed Bell and Spigot: Provide pipe manufacturer's standard design, meeting the requirements of AWWA C200.
 - b. Welded: Provide electrodes complying with AWWA C206.
 - c. Sleeve Type Mechanical Coupled:
 - 1) Designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections and provide for confinement and compression of gaskets.
 - 2) Coupling Assembly:
 - (a) One steel middle ring, flared or beveled at each end, providing a gasket seat and two steel or malleable iron follower rings, providing for confinement and compression of the gaskets.
 - (b) Provide middle ring and follower rings consisting of true, circular sections, free from irregularities, flat spots, and surface defects.
 - (c) Two resilient and tapered rubber gaskets, designed for resistance to set after installation.
 - (d) Bolts and nuts to draw the follower rings toward each other to compress the gaskets.
 - 3) Bolts: Track head complying with ASTM A307 Grade A, with nuts complying with ASTM A563/A563M Grade A.
 - 4) Coupling Strength: Not less than adjoining pipeline.
 - d. Grooved and Shouldered:
 - 1) Groove pipe ends by roll grooving or provide weld-on adapters with cut grooves.
 - 2) Groove dimensions by roll grooving as recommended by the coupling manufacturer.
 - 3) Dimensions of grooves cut in adapters to comply with AWWA C606.
 - 4) Comply with AWWA C606 for pipe ends.
 - 5) Joint dimensions to comply with AWWA C606 for rigid joints and as indicated for flexible joints.
 - e. Flanged:
 - 1) Steel Flanges: AWWA C207, Class D.
 - 2) Bolts, Nuts, and Rubber Gaskets: AWWA C207.
 - 3) Asbestos gaskets not allowed.
 - f. Insulating Joints:
 - 1) Provide flanged type with insulating gasket, bolt sleeves, and washers to prevent metal-to-metal contact with adjacent piping.
 - 2) Gaskets: Dielectric type, full face, as recommended in Appendix to AWWA C115/A21.15.
 - 3) Bolts and Nuts: As recommended in Appendix to AWWA C115/A21.15.
- 6. Lining:
 - a. Cement-Mortar Lining: AWWA C602 applied in-place.
 - b. Cement-Mortar Coating: AWWA C205, factory applied.
 - c. Coal-Tar Enamel Coating, factory applied:

- 1) Except where indicated, prepare, prime, and coat piping with hot-applied coal-tar enamel and bonded single layer of felt wrap in accordance with AWWA C203.
- 2) Asbestos felt not allowed.
- 3) Felt Material: Fibrous-glass matt complying with AWWA C203.
- d. Coal-Tar Epoxy Coating, Shop Applied: Clean, prime, and topcoat piping with coaltar epoxy coating system in accordance with AWWA C210.
- B. Steel Pipe and Fittings:
 - 1. Pipe: Standard weight, zinc-coated complying with ASTM A53/A53M.
 - 2. Fittings: Comply with ASME B16.4, Class 125, zinc-coated or ASME B16.3, Class 150, zinc-coated, threaded.
 - 3. Mechanically Factory Applied Protective Materials:
 - a. Clean by wire brushing and solvent cleaning.
 - b. Apply one coat of coal-tar primer and two coats of coal-tar enamel complying with AWWA C203.
 - c. Protect threaded pipe ends and fittings prior to coating.
- C. Ductile Iron Pipe: AWWA C151/A21.51:
 - 1. Fittings: Ductile iron, standard thickness.
 - 2. Joints: AWWA C111/A21.11, Styrene butadiene rubber (SBR) or vulcanized SBR gasket with rods.
 - 3. Jackets: AWWA C105/A21.5 polyethylene jacket.
- D. Copper Tubing: ASTM B88, Type K, Annealed:
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
- E. PVC Pipe: ASTM D1785 Schedule 40.
 - 1. Fittings: ASTM D2466, PVC.
 - 2. Joints: ASTM D2855, solvent weld.
- F. PVC Pipe: AWWA C900 Class 100:
 - 1. Fittings: AWWA C111/A21.11, Schedule 40 per ASTM D2466 or schedule 80 per ASTM D2467.
 - 2. Joints: ASTM D3139 compression gasket ring.
- G. Polyethylene Pipe: ASTM D3035, for 45 psig pressure rating (ASTM D3035, for 315 kPa pressure rating):
 - 1. Fittings: AWWA C901, molded or fabricated.
 - 2. Joints: Compression.
- H. Polyethylene Pipe: AWWA C901:
 - 1. Fittings: AWWA C901, molded or fabricated.
 - 2. Joints: Compression.
- I. Crosslinked Polyethylene Tubing: AWWA C904.
 - 1. Fittings: AWWA C800, insert-stiffener type.
 - 2. Joints: Cold expansion fittings with PEX reinforcing rings, complying with ASTM F1960
- J. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

2.02 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gate Valves Up To 3 Inches (75 mm):
 - 1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.
- C. Gate Valves 3 Inches (75 mm) and Over:
 - 1. AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, post indicator, valve key, and extension box.

- 2. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, post indicator, valve key, and extension box.
- D. Ball Valves Up To 2 Inches (50 mm):
 - 1. Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, compression outlet with electrical ground connector, with control rod, valve key, and extension box.
- E. Swing Check Valves From 2 Inches to 24 Inches (50 mm to 600 mm):
 - 1. AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.
- F. Butterfly Valves From 2 Inches to 24 Inches (50 mm to 600 mm):
 - 1. AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, ten position lever handle.

2.03 HYDRANTS

- A. Hydrants: Type as required by utility company.
- B. Hydrants: AWWA C502, UL 246, dry barrel type.
 - 1. Inside dimension: 7 inches (175 mm) minimum, with minimum 5 inches (125 mm) diameter valve seat opening.
 - 2. Minimum net water area of barrel not less than 190 percent of valve opening.
 - 3. 6 inch (150 mm) bell or mechanical joint inlet connection with accessories, gland bolts, and gaskets.
- C. Hydrant Extensions: Fabricate in multiples of 6 inches (150 mm) with rod and coupling to increase barrel length.
- D. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles , one pumper nozzle.
- E. Pressure Rating: According to utility company.
- F. Finish: Primer and two coats of enamel in color required by utility company.

2.04 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 033000.
- B. Backflow Preventer: Reference plans and manufactures specifications.
- C. Meter: Reference LUS standard.
- D. Manhole and Cover: Refer to Section 330561.
- E. Casing Spacer: Stainless steel spacer designed to maintain pipe casing integrity.

PART 3 EXECUTION

3.01 INSTALLATION - PIPE

- A. Maintain separation of water main from sewer piping in accordance with pumbling code.
- B. Group piping with other site piping work whenever practical.
- C. Install pipe to indicated elevation to within tolerance of 5/8 inches (16 mm).
- D. Install ductile iron piping and fittings to AWWA C600.
- E. Install grooved and shouldered pipe joints to AWWA C606.
- F. Install crosslinked polyethylene tubing and fittings to AWWA C904.
- G. Route pipe in straight line.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Slope water pipe and position drains at low points.

3.02 INSTALLATION - STEEL PIPE

3.03 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway in accordance with Section 211100.
- D. Set hydrants to grade, with nozzles at least 20 inches (500 mm) above ground in accordance with Section 211100.
- E. Locate control valve 4 inches (100 mm) away from hydrant.
- F. Provide a drainage pit 36 inches (900 mm) square by 24 inches (600 mm) deep filled with 2 inches (50 mm) washed gravel. Encase elbow of hydrant in gravel to 6 inches (150 mm) above drain opening. Do not connect drain opening to sewer.
- G. Paint hydrants in accordance with Section 099113.

3.04 SERVICE CONNECTIONS

A. Provide water service to utility company requirements with reduced pressure backflow preventer and water meter with bypass valves and sand strainer.

SECTION 333113 SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete: Concrete for cleanout base pad construction.
- B. Section 312316.13 Trenching: Excavating, bedding, and backfilling.

1.02 PRICE AND PAYMENT PROCEDURES

- A. See Section 012200 Unit Prices, for additional unit price requirements.
- B. Pipe and Fittings:
 - 1. Basis of Measurement: By the linear foot (meter).
 - 2. Basis of Payment: Includes hand trimming excavation, bedding, pipe and fittings, connection to building service piping and to municipal sewer.
- C. Cleanout:
 - 1. Basis of Payment: Includes hand trimming excavating, foundation pad, unit installation with accessories, connection to sewer piping.

1.03 REFERENCE STANDARDS

- A. ASTM A74 Standard Specification for Cast Iron Soil Pipe and Fittings 2021.
- B. ASTM A746 Standard Specification for Ductile Iron Gravity Sewer Pipe 2018 (Reapproved 2022).
- C. ASTM C12 Standard Practice for Installing Vitrified Clay Pipe Lines 2022a.
- D. ASTM C14 Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe 2020.
- E. ASTM C14M Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric). 2020.
- F. ASTM C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe 2022a.
- G. ASTM C76M Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric) 2022a.
- H. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets 2021.
- I. ASTM C443M Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric) 2021.
- J. ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.
- K. ASTM C700 Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated 2018 (Reapproved 2022).
- L. ASTM D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2021a.
- M. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2020.
- N. ASTM D2680 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping 2020.
- O. ASTM D2729 Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.
- P. ASTM D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

- Q. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials 2021.
- R. AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents:
 - 1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. Cast Iron Soil Pipe: ASTM A74, service type, hub and spigot end.
- C. Joint Seals for Cast Iron Pipe: ASTM C564 rubber gaskets.
- D. Ductile Iron Pipe: ASTM A746, Pressure Class 350, with asphaltic lining, bell and spigot end.
- E. Joint Seals for Ductile Iron Pipe: AWWA C111/A21.11; styrene butadiene rubber (SBR) or vulcanized SBR gaskets.
- F. Vitrified Clay Pipe: ASTM C700, extra strength, unperforated; bell and spigot end joints.
- G. Joint Seals for Clay Pipe: ASTM C425 compression gasket joint devices.
- H. Concrete Pipe: Nonreinforced, ASTM C14 or ASTM C14M, Class 1; , bell and spigot end joints.
- I. Joint Seals for Concrete Pipe: ASTM C443 (ASTM C443M) rubber compression gaskets.
- J. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class II with Wall type A; mesh reinforcement; bell and spigot end joints.
- K. Plastic Pipe: ASTM D2680 Acrylonitrile-Butadiene-Styrene (ABS) material; bell and spigot style solvent sealed joint end.
- L. Plastic Pipe: ASTM D2729, Poly(Vinyl Chloride) (PVC) material; bell and spigot style solvent sealed joint end.
- M. Plastic Pipe: ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; bell and spigot style solvent sealed joint end.
- N. Plastic Pipe: ASTM D1785, Schedule 40, Poly(Vinyl Chloride) (PVC) material; bell and spigot style solvent sealed joint end.
- O. Plastic Pipe: ASTM D3350, SDR 11, High Density Polyethylene (HDPE) material; with cell classification of 335434C or better, thermal butt fusion joints and fittings in accordance with manufacturer's recommendations; pipe and fittings same material utilizing transition fittings when connecting to existing piping.
- P. Joint Seals: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- Q. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.02 PIPE ACCESSORIES

- A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.
- B. Casing Spacer: Polyethylene spacer designed to maintain pipe casing integrity.

2.03 CLEANOUT MANHOLE

- A. Lid and Frame: Cast iron construction, hinged lid.
 - 1. Lid Design: Open checkerboard grille.
 - 2. Nominal Lid and Frame Size: 26 inches (660 mm).
- B. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches (300 mm); nominal shaft diameter of 36 inches (900 mm).
- C. Base Pad: Cast-in-place concrete of type specified in Section 033000, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

2.04 BEDDING AND COVER MATERIALS

- A. Pipe Bedding Material: As specified in Section 312323.
- B. Pipe Cover Material: As specified in Section 312323.

PART 3 EXECUTION

3.01 TRENCHING

- A. See Section 312316.13 for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Clay Pipe: Also comply with ASTM C12.
 - 2. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- D. Connect to building sanitary sewer outlet and municipal sewer system , through installed sleeves.
- E. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

3.03 INSTALLATION - CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

SECTION 334100 SUBDRAINAGE

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM C4 Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile 2004 (Reapproved 2018).
- B. ASTM C412 Standard Specification for Concrete Drain Tile 2019.
- C. ASTM C412M Standard Specification for Concrete Drain Tile (Metric) 2019.
- D. ASTM D2729 Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

1.02 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe drainage products, and pipe accessories.
- C. Shop Drawings: Indicate dimensions, layout of piping, high and low points of pipe inverts, and gradient of slope between corners and intersections.
- D. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

- A. Polyvinyl Chloride Pipe: ASTM D2729; plain end, 4 inch (100 mm) inside diameter; with required fittings.
- B. Bituminous Fiber Pipe: With Type split collar or internal coupling joints; 4 inch (100 mm) inside diameter; with necessary fittings.
- C. Clay Pipe: ASTM C4 Standard Class, 4 inch (100 mm) inside diameter, with required fittings.
- D. Concrete Pipe: ASTM C412 (ASTM C412M) Standard-Quality, 4 inch (100 mm) inside diameter, with required fittings.
- E. Corrugated Plastic Tubing: Flexible type; 4 inch (100 mm) diameter, with required fittings.
- F. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.02 AGGREGATE AND BEDDING

- A. Filter Aggregate and Bedding Material: Granular fill as specified in Section 312323.
- B. Filter Sand and Bedding Material: Sand as specified in Section 312323.
- C. Impervious Fill Material: as specified in Section 312323.

2.03 ACCESSORIES

- A. Pipe Couplings: Solid plastic.
- B. Joint Covers: No. 15 asphalt saturated roofing felt.
- C. Filter Fabric: Water pervious type, black polyolefin.
- D. Geotextile Fabric: As specified in Section 310519.
- E. Sleeve: for foundation wall.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.
- B. Place drainage pipe on clean cut subsoil.

C. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

SECTION 334211 STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.02 PRICE AND PAYMENT PROCEDURES

- A. See Section 012200 Unit Prices, for additional unit price requirements.
- B. Pipe and Fittings:
 - 1. Basis of Measurement: By the linear foot (meter).
 - 2. Basis of Payment: Includes hand trimming excavation, bedding and backfilling, pipe and fittings, connection to building service piping and to municipal system.

1.03 REFERENCE STANDARDS

- A. AASHTO M 252 Standard Specification for Corrugated Polyethylene Drainage Pipe 2021.
- B. AASHTO M 294 Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter 2021.
- C. ASTM A48/A48M Standard Specification for Gray Iron Castings 2022.
- D. ASTM C14 Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe 2020.
- E. ASTM C14M Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric). 2020.
- F. ASTM C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe 2022a.
- G. ASTM C76M Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric) 2022a.
- H. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets 2021.
- I. ASTM C443M Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric) 2021.
- J. ASTM D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2021a.
- K. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2020.
- L. ASTM D2680 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping 2020.
- M. ASTM D2729 Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.
- N. ASTM D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.
- O. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials 2021.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- D. Field Quality Control Submittals: Document results of field quality control testing.

- E. Project Record Documents:
 - 1. Record location of pipe runs, connections, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 STORMWATER PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. Concrete Pipe: Nonreinforced, ASTM C14 (ASTM C14M), Class 1; bell and spigot end joints.
- C. Concrete Pipe Joint Devices: ASTM C443 (ASTM C443M) rubber compression gasket joint.
- D. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class II with Wall type A; mesh reinforcement; bell and spigot end joints.
- E. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.
- F. Plastic Pipe: ASTM D2680, Acrylonitrile-Butadiene-Styrene (ABS) material, bell and spigot style solvent sealed joint end.
- G. Plastic Pipe: ASTM D2729, Poly Vinyl Chloride (PVC) material; bell and spigot style solvent sealed joint end.
- H. Plastic Pipe: ASTM D3034, Type PSM, Poly Vinyl Chloride (PVC) material; bell and spigot style solvent sealed joint end.
- I. Plastic Pipe: ASTM D1785, Schedule 40, Poly Vinyl Chloride (PVC) material; bell and spigot style solvent sealed joint end.
- J. Plastic Pipe: ASTM D3350, SDR 11; High Density Polyethylene (HDPE) solid wall pipe; with cell classification of 335434C or better, thermal butt fusion joints in accordance with manufacturer's recommendations.
- K. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner; meeting the requirements of AASHTO M 252, Type S, for diameters between 3 inches (75 mm) and 10 inches (250 mm) and AASHTO M 294, Type S, for diameters between 12 inches (300 mm) and 60 inches (1500 mm), soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.
- L. Corrugated Steel Pipe: AASHTO M 36 Type I, end joints; helical lock seam; coated inside and out with 0.050 inch (1.3 mm) thick bituminous coating.
- M. Coupling Bands: Galvanized steel, 0.052 inches (1.3 mm) thick x 10 inches (250 mm) wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

2.02 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- B. Filter Fabric: Non-biodegradable, woven.
- C. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Stormwater Service" in large letters.
- D. Downspout Boots: Smooth interior without boxed corners or choke points; include integral lug slots and on-body cleanout and cover with neoprene gaskets.
 - 1. Configuration: Angular.
 - 2. Material: Cast iron; ASTM A48/A48M; casting thickness 3/8 inch (9.5 mm), minimum.
 - 3. Finish: Manufacturer's standard factory applied powder coat finish.
 - 4. Color: To be selected by Architect from manufacturer's standard range.
 - 5. Accessories: Manufacturer's standard stainless steel fasteners, stainless steel building wall anchors, and rubber coupling.
 - 6. Manufacturers:

2.03 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 312316.13.
- B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.01 TRENCHING

A. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- D. Connect to building storm drainage system, foundation drainage system, and utility/municipal system.
- E. Make connections through walls through sleeved openings, where provided.
- F. Install continuous trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

SECTION 334213 STORMWATER CULVERTS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 313213.16 - Cement Soil Stabilization.

1.02 REFERENCE STANDARDS

- A. ASTM A929/A929M Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe 2018.
- B. ASTM C14 Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe 2020.
- C. ASTM C14M Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric). 2020.
- D. ASTM C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe 2022a.
- E. ASTM C76M Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric) 2022a.
- F. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets 2021.
- G. ASTM C443M Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric) 2021.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe, fittings and accessories.
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

PART 2 PRODUCTS

2.01 CULVERT PIPE, GENERAL

A. Regulatory Requirements: Comply with applicable code for materials and installation of the work of this section.

2.02 STEEL CULVERT PIPE

- A. Corrugated Steel Pipe: Fabricated of ASTM A929/A929M galvanized steel sheet:
 - 1. Helical lock seam.
 - 2. Coated inside and out with 0.050 inch (1.3 mm) thick bituminous coating.
- B. Tapered Ends: Same material as pipe, machine cut, for joining to pipe end.
- C. Coupling Bands: Galvanized steel, 0.052 inches (1.3 mm) thick x 10 inches (250 mm) wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

2.03 CONCRETE CULVERT PIPE

- A. Concrete Pipe: Nonreinforced, ASTM C14 (ASTM C14M), Class 1:
 - 1. Bell and spigot end joints.
 - 2. Shape: Circular with a nominal diameter of N/A $_{\rm N/A}$ inches (Circular with a nominal diameter of N/A $_{\rm N/A}$ mm).
- B. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class I with Wall Type A; mesh reinforcement; bell and spigot end joints:
 - 1. Shape: Circular with a nominal diameter of N/A inches (Circular with a nominal diameter of N/A mm).
- C. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.
2.04 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 312316.13.
- B. Cover: As specified in Section 312316.13.

2.05 ACCESSORIES

- A. Filter Fabric: Non-biodegradable, woven.
- B. Fill at Pipe Ends: Soil cement material blend as specified in Section 313213.16 with 6 percent cement, premixed and burlap bagged for moist cure on site.
- C. Fill at Pipe Ends: Riprap as specified in Section 313700.
- D. Fill at Pipe Ends: Concrete grout fill as specified in Section 033000.

PART 3 EXECUTION

3.01 EXCAVATING

- A. Excavate culvert trench to 12 inches (300 mm) below pipe invert. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place filter fabric over compacted backfill.

3.02 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe and accessories in accordance with manufacturer's instructions
- C. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.
- D. Shore pipe to required position; retain in place until after compaction of adjacent fills. Ensure pipe remains in correct position and to required slope.
- E. Repair surface damage to pipe protective coating with two coats of compatible bituminous paint coating.
- F. Install culvert end gratings.

3.03 PIPE ENDS

3.04 TOLERANCES

A. Lay pipe to alignment and slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

END OF SECTION

SECTION 334230 STORMWATER DRAINS

PART 1 GENERAL

1.01 PRICE AND PAYMENT PROCEDURES

- A. See Section 012200 Unit Prices for additional unit price requirements.
- B. Catch Basins and Drop Inlets:
 - 1. Basis of Measurement: By the unit for a nominal.
 - 2. Basis of Payment: Includes excavation, hand trimming, bedding and backfilling, base pad, frame and grate, accessories.
- C. Trench Drains:
 - 1. Basis of Measurement: By the linear foot (meter).
 - 2. Basis of Payment: Includes excavation, hand trimming, bedding and backfilling, frame and grate, accessories.

1.02 REFERENCE STANDARDS

- A. AASHTO HB Standard Specifications for Highway Bridges 2005, with Errata.
- B. ACI 211.1 Selecting Proportions for Normal-Density and High Density-Concrete Guide 2022.
- C. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- D. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete 2022a.
- E. ASTM C139 Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes 2017.
- F. ASTM C270 Standard Specification for Mortar for Unit Masonry 2019a, with Editorial Revision.
- G. ASTM C478/C478M Standard Specification for Circular Precast Reinforced Concrete Manhole Sections 2020.
- H. ASTM C990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants 2009 (Reapproved 2019).
- I. ASTM C1634 Standard Specification for Concrete Facing Brick and Other Concrete Masonry Facing Units 2020.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Weight rating for catch basins, drop inlets, trench drains, and frame and grates.
- C. Shop Drawings: Indicate stack assembly, invert elevations, opening sizes, and pipe angles.
- D. Manufacturer's Installation Instructions: Indicate special procedures for assembly.
- E. Designer's qualification statement.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- I. Field Quality Control Submittals: Document results of field quality control testing.
- J. Project Record Documents:
 - 1. Record invert elevations of catch basins, drop inlets, and trench drains.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 CATCH BASINS

A. Weight Rating: H 10 according to AASHTO HB.

- B. Precast Concrete Catch Basins: Comply with ASTM C478/C478M, reinforced.
 - 1. Wall Thickness: 6 inches (152 mm).
 - 2. Base Thickness: 12 inches (305 mm).
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 4. Joint Sealant: Comply with ASTM C990.
- C. Concrete Masonry Unit Catch Basins: Comply with ASTM C139, reinforced.
 - 1. Concrete Blocks: Curvedsolid.
 - 2. Mortar: Type M, in accordance with ASTM C270.
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
- D. Cast-In-Place Concrete Catch Basins: Comply with ASTM C94/C94M, reinforced.
 1. Wall Thickness: 6 inches (152 mm).
- E. Cast-In-Place Concrete Base Pads: Comply with ASTM C94/C94M, reinforced.1. Thickness: 12 inches (305 mm).
 - 2. Width: Match outside catch basin diameter.
- F. Grade Adjustments:
 - 1. Concrete Bricks: ASTM C1634 or ASTM C55 Grade N, cored, normal weight.
- G. Frames and Grates: Steel, checkerboard pattern.

2.02 DROP INLETS

2.

- A. Weight Rating: Pedestrian according to AASHTO HB.
- B. Prefabricated Drop Inlet: Polymer concrete, glass fiber reinforced, metal installation brackets.
- C. Frames and Grates: Galvanized steel support, steel grate, checkerboard pattern, match drain opening size.

2.03 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

- A. Lids and Drain Covers: Cast iron, hinged to cast iron frame.
 - 1. Catch Basin:
 - a. Lid Design: Linear grill.
 - Cleanout:
 - a. Lid Design: Linear grill.
 - 3. Area Drain:
 - a. Lid Design: Linear grill.
 - 4. Trench Drain:
 - a. Lid Design: Linear grill.

2.04 PREFABRICATED TRENCH DRAINS

- A. Prefabricated Trench Drain: Polymer concrete, glass fiber reinforced, metal installation brackets.
 - 1. Weight Rating: Pedestrian according to AASHTO HB.
 - 2. Frames and Grates: Galvanized steel support, steel grate, linear pattern, match drain opening size.

PART 3 EXECUTION

3.01 EXCAVATION AND FILL

- A. Hand trim excavation for accurate placement to indicated elevations.
- B. Backfill with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION

- A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.
- B. Concrete Mixing:
 - 1. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

- 2. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- C. Precast Concrete Catch Basins:
 - 1. Place base section plumb and level.
 - 2. Install joint sealant uniformly around section lip.
 - 3. Install cone or lid plumb and level on joint sealant.
- D. Cast-In-Place Concrete Base Pad:
 - 1. Form bottom of excavation walls clean and smooth to correct limits.
 - 2. Install reinforcement in maximum lengths. Offset end laps in both directions. Splice laps with tie wire.
 - 3. Place concrete in accordance with ACI 304R.
 - 4. Float base pad top surface level.
- E. Concrete Masonry Unit Catch Basins:
 - 1. Place full mortar bed on concrete base pad.
 - 2. Lay masonry units plumb on mortar with full head joints and uniform concave vertical joints.
 - 3. Maintain level running bond courses with uniform concave horizontal joints.
 - 4. Install joint reinforcement 16 inches (400 mm) on center.
 - 5. Taper diameter to opening in 4 courses.
- F. Cast-In-Place Concrete Catch Basins:
 - 1. Form catch basin on concrete base pad plumb and level.
 - 2. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
 - 3. Install reinforcement in maximum lengths. Offset end laps in both directions. Splice laps with tie wire.
 - 4. Place concrete in accordance with ACI 304R.
 - 5. Float catch basin top surface level.
- G. Prefabricated Drop Inlets or Trench Drains:
 - 1. Place base section plumb and level.
 - 2. Install according to manufacturer's instructions.
 - 3. Secure installation brackets.
- H. Grade Adjustments:
 - 1. Lay brick or masonry units uniformly on mortar bed with full head joints, running bond. Top with mortar, plumb and level.
 - 2. Place adjacent materials tight and smooth following design grades.
- I. Frames and Grates:
 - 1. Place frame plumb and level.
 - 2. Mount frame on prefabricated drop inlets or trench drains according to manufacturer's instructions.
 - 3. Place grate in frame securely.

END OF SECTION

SECTION 334600 STORMWATER MANAGEMENT

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete.
- B. Section 310519 Geosynthetics for Earthwork.
- C. Section 312323 Fill.

1.02 PRICE AND PAYMENT PROCEDURES

A. Unit Prices:

- 1. See Section 012200 Unit Prices for additional requirements.
- 2. Basis of Measurement for Stormwater Ponds: By cubic yard (cubic meter).
- 3. Basis of Measurement for Outlet Structures for Stormwater Ponds: Per unit.
- 4. Basis of Measurement for Modular Buried Stormwater Storage Units: Per unit.
- 5. Basis of Measurement for Stormwater Leaching Pits: Per unit.

1.03 REFERENCE STANDARDS

- A. ASTM A48/A48M Standard Specification for Gray Iron Castings 2022.
- B. ASTM A929/A929M Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe 2018.
- C. ASTM C913 Standard Specification for Precast Concrete Water and Wastewater Structures 2021.
- D. ASTM D3282 Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes 2015.
- E. ASTM D6637/D6637M Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method 2015.
- F. GRI GM13 Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes 2021.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data on each product to be used, including physical properties, seaming materials, and installation instructions.
- C. Shop Drawings: Indicate stack assembly, invert elevations, opening sizes, and pipe angles.
- D. Test Reports: Indicate optimum moisture content of fill materials.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Testing agency's qualification statement.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.

PART 2 PRODUCTS

2.01 STORMWATER PONDS

- A. Fill: See Section 312323.
- B. Impermeable Layer: Group A-4 in accordance with ASTM D3282.
- C. Geogrid: Geogrid for stabilization as specified in Section 310519.

2.02 OUTLET STRUCTURES FOR STORMWATER PONDS

A. Precast Concrete: Reinforced, integrated lift rings, in accordance with ASTM C913.

- 1. Concrete: 4,000 psi (27.5 MPa) minimum 28 day compressive strength.
- 2. Wall Thickness: 4 inches (102 mm).
- B. Corrugated Metal: Galvanized sheet steel in accordance with ASTM A929/A929M with helical lock seams.
- C. Trash Racks: Cast iron, heavy duty bar screen.
- D. Concrete Base: See Section 033000.

2.03 MODULAR BURIED STORMWATER STORAGE UNITS

- A. Modular Plastic: Open cell, interlocking, 100 percent recycled.
- B. Geogrid: 1,300 lb/ft (19.0 kN/m) minimum ultimate tensile strength, when tested in accordance with ASTM D6637/D6637M.
- C. Geomembrane: HDPE, comply with GRI GM13.

2.04 STORMWATER LEACHING PITS

- A. Precast Concrete: Reinforced, integrated lift rings, inlet inspection hole, in accordance with ASTM C913.
 - 1. Concrete: 4,000 psi (27.5 MPa) minimum 28 day compressive strength.
 - 2. Wall Thickness: 4 inches (102 mm).
 - 3. Perforations: 15 percent of wall area.
- B. Concrete Masonry Unit: Solid, straight blocks.
 - 1. Concrete: 4,000 psi (27.5 MPa) minimum 28 day compressive strength.
 - 2. Dimensions: 8 by 8 by 16 inches (203 by 203 by 406 mm).
 - 3. Cover: Precast, integrated lift rings.
- C. Frame and Grate: ASTM A48/A48M, Class 30B cast iron construction, machined flat bearing surface.

PART 3 EXECUTION

3.01 POND CONSTRUCTION

- A. Install geogrid according to manufacturer's instructions.
- B. Fill to contours and elevations indicated using unfrozen materials.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.

3.02 POND OUTLET CONSTRUCTION

- A. Form concrete base pad according to drawings, trowel top surface level.
- B. Precast Structure: Place structure sections plumb and level, trim to correct elevations.
 1. Anchor to base pad.
- C. Corrugated Structure: Install elbow fitting and sections plumb and level, trim to correct elevations.
 - 1. Anchor to base pad.
- D. Set trash racks level without tipping, to correct elevations.

3.03 MODULAR UNIT INSTALLATION

- A. Install modular units according to manufacturer's instructions.
- B. Lay geogrid sheets on base in the direction of construction.
- C. Lay geomembrane sheets on geogrid in the direction of construction.
- D. Install modular units according to drawings, interlocking wherever possible.
- E. Lay geogrid sheets on modular units in the direction of construction.

- F. Cover top and sides of modular units with geomembrane, weld seams according to manufacturer's instructions.
- G. Backfill without damaging modular units, geomembrane, or geogrid as specified in Section 312323.

3.04 LEACHING PIT INSTALLATION

- A. Precast Concrete: Place structure sections plumb and level, trim to correct elevations.
- B. Concrete Masonry Unit: Place masonry units plumb and level in running bond with open joints.
- C. Set cover level without tipping, to correct elevations.
- D. Install frames and grate to correct position and elevation.
- E. Backfill 12 inches (305 mm), minimum, around pit with stone as specified in Section 312323.

END OF SECTION

SECTION 02510

WATER MAIN DISTRIBUTION SYSTEM

PART I GENERAL

1.01 SECTION INCLUDES

- A. Pipe Materials and Fittings
- B. Main Installation
- C. Testing and Disinfection

1.02 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all labor and material for the construction of water lines and appurtenances as described in the plans and elsewhere in the specifications.

1.03 REFERENCES

- A. ANSI/ASTM D 1784 Rigid Poly (vinyl Chloride) (PVC) Compounds.
- B. ANSI/ASTM D 2241 Poly (vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
- C. ANSI/AWWA C104/A21.4 Cement Mortar Lining for Ductile-Iron Pipe and Fittings.
- D. ANSI/AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In.
- E. ANSI/AWWA C111/A21.11 Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- F. ANSI/AWWA C150/A21.50 Thickness Design of Ductile-Iron Pipe.
- G. ANSI/AWWA C151/A21.51 Ductile-Iron Pipe for Water or Other Liquids.
- H. AWWA C651 Disinfecting Water Mains.
- I. AWWA C900 Poly (vinyl Chloride) (PVC) Pressure Pipe 4 In. through 12 In.
- J. AWWA C605 Underground Installation of PVC Pressure Pipe & Fittings for Water.

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1.04 REGULATORY REQUIREMENTS

A. Conform to applicable state and local codes for installation and testing of the work in this section.

1.05 QUALITY CONTROLS

- A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of AWWA or the appropriate ASTM standard.
- B. Submit manufacturer's certifications that ductile iron pipe and fittings meet requirements of the appropriate ANSI standard.

1.06 MEASUREMENT AND PAYMENT

- A. Method of Measurement:
 - 1. Water Main: Water main installed will be measured by the linear foot of the various sizes and types actually installed excluding water main that is required to complete other items of work that have been defined in the bid. Measurement shall be continuous from end to end without deductions for fittings, valves, or jack or bored mains.
 - 2. Fittings: Ductile iron fittings installed with water lines shall be measured by the ton, based on the catalog weight per fitting. The weights of the fittings shall be exclusive of bolts, nuts, and gaskets and exclusive of glands when a retainer is used. All fittings not specifically included in the other items of work defined in the proposal shall be included in this measurement.
 - 3. Jacking or Boring: Jacking or boring measurement shall be by the linear foot and shall be the actual center line length of pipe so installed as measured from the vertical cut on each side of the obstruction to be bored but shall not exceed two (2') feet beyond obstruction. Jacking or boring operations shall in no way interfere with the operation of railroads, streets, highways, or other facilities and shall not weaken or damage such facilities. Jacking or boring HDPE pipe quantity shall include adapters, reducers, and fittings necessary to tie-in HDPE pipe with PVC pipe.
 - 4. Casing Pipe: The basis of measurement for casing pipe shall be by the linear foot and shall be the actual center line of casing so installed.
 - 5. Stream Crossing: Stream crossing shall be measured by the lump sum for the limits designated in the water details which includes pipe, fittings, and all incidentals necessary to complete the work for this item.

- 6. Tie-In To Existing Mains: Tie-in connections to existing mains shall be paid for per each. Valves and fittings are measured and paid for under other items.
- 7. Select Fill: Select fill for foundation or for backfill over pipe shall be measured by the cubic yard based on the truck volume placed, as ordered by the Engineer.
- B. Payment:
 - 1. Water Main: Payment for water main installed, tested, and accepted will be made at the unit price bid per linear foot of pipe of the various sizes. Such payment shall also include excavation, backfill, hauling, and disposition of surplus excavated material.
 - 2. Fittings: Payment shall be based on the number of tons actually installed and shall be made at the price bid per ton. Payment shall include full compensation for all labor, materials, supplies, thrust blocks, anchors, equipment, tools and incidentals necessary for completely installing the fittings in accordance with these specifications and the contract drawings.
 - 3. Jacking or Boring: The work performed and materials furnished as specified herein shall be paid for at the contract unit price bid per linear foot of jacking or boring, which price shall be full compensation for furnishing all materials (except carrier pipe, casings, or liners), labor, tools, equipment and incidentals necessary to complete the work.
 - 4. Casing Pipe: Payment for casing installed will be at the unit price bid for furnishing and installing the casing pipe. No direct payment will be made for casing spacers installed around the carrier pipe in the casing.
 - 5. Stream Crossing: Payment for stream crossing shall be lump sum as stipulated in the bid. This work will consist of furnishing all labor, material, equipment, tools and other incidentals necessary to complete this item as shown on the plans.
 - 6. Tie-In To Existing Mains: Tie-in to existing main shall be paid for per each and includes full compensation for furnishing all equipment, tools, labor, and incidentals necessary to complete the connection.
 - 7. Select Fill: Payment for select fill shall be by the cubic yard at the unit price bid and shall constitute full compensation for furnishing, hauling, placing the fill and removal of excavated material.

PART 2 PRODUCTS

2.01 WATER MAIN

- A. PVC Pipe (2 Inch)
 - 1. Pipe and fittings shall be made from clean, virgin NSF approved Type I, Grade I PVC conforming to ASTM Resin Specification D1784-65T.
 - 2. Clean, reworked material generated from the manufacturer's own pipe production may be used.
 - 3. Pipe shall meet working pressure of 160 psi, SDR 26, Commercial Standard C5256-63, and be approved by the National Sanitation Foundation. Laying lengths shall be 20 feet ± 1 inch.
 - 4. Fittings shall be brass, compression type.
 - 5. Provisions must be made for contraction and expansion at each joint with a rubber ring. Pipe and fitting must be assembled with a non-toxic lubricant.
 - 6. No 2" PVC pipe joint will be allowed in roadway.
- B. PVC Pipe (Above 2 Inch)
 - 1. Pipe:
 - A. 4 12 inch: AWWA C900, SDR 18, 235 psi pressure, NSF approved, 12454 B PVC compound conforming to ASTM Resin Specification D1784.
 - B. 14 24 inch: AWWA C905, SDR18 DIPS, 235 psi rating, NSF approved, 12454 B PVC compound conforming to ASTM Resin Specification D1784.
 - 2. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties.
 - 3. Fittings shall be ductile iron and conform to Section 2.01.E.
 - 4. Joints shall be made of gasket bell push-on type. Joints shall be gasket joints conforming to ASTM F477. Joints assembled with non-toxic lubricant.

- 5. All joints under roadways shall be restrained.
- 6. PVC pipe shall be supplied in standard nominal laying lengths of 20 feet. The color of pipe shall be blue or white with blue lettering. The pipe shall be marked with the size, material code, dimension ratio (DR), AWWA pressure class and AWWA designation.
- C. Ductile Iron Water Pipe

Pipe shall be designed in accordance with ANSI Specification A21.50 (AWWA C150), latest revision. All pipe shall be designed for the following minimum conditions, unless noted otherwise:

- 1. Internal working pressure of 250 psi plus 100 psi surge allowance plus safety factor of 2.
- 2. Earth load of 5 feet of cover or as shown on the plans.
- 3. Laying Condition Type 2.
- 4. AASHTO H-20, truck loading.

Pipe shall be manufactured in accordance with ANSI Specification A21.51 (AWWA C151), latest revision, except the minimum nominal wall thickness shall be as shown on the following table:

Size	Pressure Class	Thickness
6"	350	0.25
8"	350	0.25
10"	350	0.26
12"	350	0.28
14"	250	0.28
16"	250	0.30
18"	250	0.31
20"	250	0.33
24"	250	0.37
30"	250	0.42

Pipe shall be standard cement lined and seal coated on the inside with a bituminous coat in accordance with ANSI Specification A21.4 (AWWA C104), latest revision. The exterior of the pipe shall be coated, with an asphaltic coating approximately 1 mil thick in accordance with ANSI Specification A21.51 (AWWA C151), latest revision. Ductile iron pipe shall be as manufactured by American Cast Iron Pipe Company, Clow Corporation, U.S. Pipe and Foundry Company, or approved equal.

Joints shall be push-on, conforming to ANSI Specification A21.11 (AWWA C111), latest revision, unless noted otherwise. Push-on joints shall be equal to push-on joints manufactured by American Cast Iron Company, U.S. Pipe and Foundry Company, or approved equal.

Fittings shall be furnished in accordance with ANSI Specification A21.10 (AWWA C110), latest revision. Joints shall be mechanical joint or push-on, conforming to ANSI Specification A21.11 (AWWA C111), latest revision. Fittings shall conform to Section III-8.2, Technical Specifications for Water Distribution System: Valves, Hydrants, Fittings and Services, of these specifications.

All pipe is to be hydrostatically proof tested to a minimum of 75% yield strength after manufacture. The manufacturer will furnish the Owner sworn certificates that pipe has been manufactured, tested and inspected in accordance with applicable specifications.

D. Ductile Iron Restrained Joint Pipe

Restrained joint pipe shall be ductile iron pipe designed and manufactured in accordance with Section B, Ductile Iron Pipe, of this article. Restrained joint fittings and the restraining components shall be ductile iron in accordance with the applicable requirements of ANSI/AWWA C110/A21.10, C111/A21.11 and C153/A21.53.

Restrained joint pipe and fittings for 12 inch and smaller diameter pipe shall be "Flex-Ring" by American Cast Iron Pipe Company, "TR-Flex" by U.S. Pipe and Foundry Company, "Super-Lock" by Clow Corporation, or approved equal. Restrained joint pipe and fittings for 14 inch and larger diameter pipe shall be "Lok-Ring" by American Cast Iron Pipe Company, "TR-Flex" by U.S. Pipe and Foundry Company, "Super-Lock" by Clow Corporation, or approved equal. Fittings for use with restrained joint pipe shall be ductile iron and shall conform to ANSI/AWWA C110/A21.10 and C153/A21.53. Where bolts are required, they shall be corrosion resistant. Field cut restrained joints shall be installed in accordance with the manufacturer's recommendations.

E. Fittings

Ductile Iron: Ductile iron fittings shall be standard body ANSI A21.10/AWWA C110 or compact body ANSI A21.53/AWWA C153. The rated working pressure shall be 350 psi. Sufficient quantities of gaskets, glands, bolts and nuts shall be furnished to provide for each socket opening. Bolts and nuts shall be alloy steel (Corten Type). All fittings shall be asphalt coated outside and cement lined and seal coated inside in accordance with ANSI A21.4/AWWA C104. Fittings must be manufactured in the United States.

- F. Polyethylene Pipe (PE Pipe)
 - 1. Pipe: AWWA C906, SDR11, PE 3408 High Density, DIPS, Cell Classification 345434C, in accordance with ASTM D3350.
 - 2. Transition Fittings shall be a mechanical joint adapter (Harvey Adapter) fabricated from HDPE pipe conforming to ASTM 3350. The fitting shall have a pre-positioned stiffener and shall offer full axial restraint.
- G. Casing
 - 1. Casing shall be welded smooth steel pipe conforming to APL 5L, Grade B or ASA B36.10, coated inside and outside with asphalt or painted with two coats of bitumastic paint.
 - 2. Minimum thickness of 0.375 inches is required.
 - 3. Spacers shall be provided at manufacturer's recommended increments.
- H. Polyethylene Encasement
 - 1. Polyethylene wrap is to be used in open-cut construction for ductile iron pipe when a cathodic protection system is required.
 - 2. Polyethylene encasement shall conform to AWWA C105.
 - 3. Film shall be Class C-Black, minimum thickness of 0.008 inches (8 mils), and furnish a certificate of conformance of the material to the requirement of AWWA C105.
 - 4. Tape shall have a pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene, minimum thickness of 8 mils, and a minimum width of 3 inches.
- I. Detection Wire
 - 1. A THW 14 insulated solid copper wire shall be placed over the center of PVC and PE pipe for the entire length including crossings.
 - 2. Attach wire to all fixtures and appurtenances to ensure continuous flow of electrical current.
 - 3. Splices in detection wire shall be installed in a direct bury splice kit manufactured by 3M or approved equal.

- 4. Detection wire and splice kit is to be included in unit price for either PVC or PE pipe.
- J. Retainer Glands
 - 1. Retainer glands and bell joint restraints shall be of the following manufacturer or approved equal:

Retainer Glands – UFR 1400 Ford or EBBA Megalug for Ductile Iron Pipe Retainer Glands – UFR 1500 Ford or EBBA Megalug for PVC Pipe Bell Joint Restraints – UFR 1390 Ford or EBBA Megalug for PVC and Ductile Iron Pipe

K. Marking Tape

All PVC pipe shall be marked using a nonmetallic tape buried at least 15 inches above the top of the pipe. Water mains shall be marked with blue tape. Tape shall be 3 inches wide minimum and on the Board's list of materials and approved manufacturers. After the tracer wire has been placed, the pipe trench shall be backfilled to approximately 15 inches over the top of the pipe then the nonmetallic tape shall be placed flat over top of pipe within trench. Backfill shall be carefully placed to a depth of 3 inches by hand to assure that the tape is secured in place over the pipe. It is the intent to provide a visible marker in the event of excavation near a water line.

2.02 WORKMANSHIP

A. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.

PART 3 EXECUTION

3.01 PREPARATION

- A. Less than 48 hour notice for approved disconnection to customers shall be the responsibility of the contractor.
- B. Identify and protect above and below grade utilities and other underground facilities to remain.
- C. Conform to applicable manufacturers installation specifications for types of pipe used.

- D. Lay pipe to lines and grades shown on drawings. Establish the route for water lines along with highway and stream crossings.
- E. Provide minimum 6 feet horizontal clearance between water mains and sewer lines running parallel and minimum 18 inch vertical clearance at crossings. In cases where it is not practical to maintain a 6 foot separation, Lafayette Utilities System (LUS) may allow deviation on a case-by-case basis.

3.02 TRENCHING

- A. Maintain a minimum cover for pipes eight (8") inches or less in diameter at 36" and for pipes ten (10") or greater at 48", except where required to meet existing water lines.
- B. The bottom of the trench shall be excavated to a uniform grade and shall be free from obstructions, which would result in the weight of the pipe being concentrated at certain points.
- C. Where subsurface obstructions are encountered in the trenching operations, the Contractor will be permitted to lay pipe above the obstruction if the minimum cover required can be obtained while providing at least three (3") inches thick clearance between the bottom of the pipe and the top of the obstruction.
- D. Where the 6" minimum cover cannot be obtained above an obstruction, the Contractor will be required to lay the pipe under the obstruction. No additional compensation for additional depth of bury will be paid for constructing the line in this manner.
- E. Maximum length of trench to be opened in advance of a section of completed water main shall be 200 feet.
- F. The Engineer shall at his discretion limit the maximum length of trench opened in advance of the completed main.
- G. The Contractor will be required to keep the sides of the trench as nearly vertical as possible by means of sheathing or bracing, as may be required to thoroughly support the sides of the excavation.
- H. If sheathing is used, the bottom width of the trench in the clear shall be twelve (12") inches wider than the greatest horizontal diameter of the water pipe. Unless otherwise ordered by the Engineer, that portion of sheathing in the trench extending below the top of the water main shall not be withdrawn before more than six (6") inches of earth is placed above the top of the main. If the sheathing cannot be removed without injury to the water main or to the adjoining structures, it shall be left in place, or it shall be cut where directed and the upper part shall be removed.
- I. Excavated material shall be placed in such a manner that will not endanger the work or prevent obstruction of sidewalks or driveways. No street shall be closed to through traffic without the permission of the Engineer.

- J. The Contractor shall take every precaution to protect existing structures and landscaping.
- K. The Contractor shall give sufficient notice to the interested utility of his intention to remove or disturb any other pipe or conduit and shall abide by their regulations governing such work.
- L. During construction operations the Contractor shall make all provisions to not disturb existing piping or conduit systems. If any existing systems are damaged, the Contractor shall be responsible for any and all repairs to the satisfaction of the Engineer.
- M. If during construction operations a utility service line is broken, the Contractor shall repair the line at his own expense, or if preferred by the utility involved, shall pay the utility for utilizing their own forces. Delays for extended periods will not be tolerated, thus the Owner reserves the right to make repairs at the Contractor's expense without prior notification.
- N. Mains shall be jack or bored under all concrete roadways and sidewalks except where specified or in special cases where no other practical method for installation is available. In the event the concrete surface is damaged during construction operations, repairs to the pavement shall be made by the Contractor at no additional cost to the Owner.
- O. Lafayette City-Parish Consolidated Government Code of Ordinance Chapter 78, Article III, Division 2 shall be followed in all trenching and backfilling operations.

3.03 DEWATERING

- A. The Contractor shall furnish all equipment necessary for pumping water accumulated in the trenches.
- B. Trenches and other excavations shall be kept clear of water while pipe is being installed or concrete structures are being constructed.
- C. No pipe or appurtenances shall be laid in water.

3.04 PIPE INSTALLATION

- A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.
- B. Where, in the opinion of the Engineer, the floor of the trench is not sufficiently stable to prevent vertical or lateral movement of the pipe after installation, the pipe shall be laid on a timber foundation or the trench shall be excavated below grade and brought back to grade with suitable filling of limestone or select fill material, as directed.
- C. Immediately prior to placement of embedment materials, the bottoms and sidewalls of trenches shall be free of loose or unsuitable soil.

- D. Thoroughly clean interior of pipe before lowering into the trench while keeping pipe interior free of foreign matter during laying operations.
- E. When work is not in progress, the ends of the pipe and fittings shall be sealed so foreign material cannot enter pipe.
- F. The pipe shall be installed and backfilled in accordance with the manufacturer's specifications. Items of work not mentioned specifically herein shall be performed in compliance with the current revision of AWWA C605, "Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water."
- G. Pipe laying operations shall not block, obstruct, or prevent streams, ditches, canals, culverts, conduits, or gutters from carrying their normal flows or of serving their normal function without the approval of the Engineer. Any disruption shall be restored by the Contractor.
- H. The trench shall provide continuous support for the pipe without voids or soft spots under the pipe.
- I. Concrete thrust blocks shall be provided at all fittings where a change of direction occurs or as specified by the Engineer for all pipe three (3") in diameter or greater. Thrust blocks shall be poured against undisturbed soil and shall not cover the bolts or nuts on the fittings. A plastic barrier shall protect bolts or nuts from being covered.
- J. The water main shall be installed in steel casing where indicated in the Drawings, typically under state highways, railroads, or as indicated by the Engineer.
- K. Pipe shall be laid beneath all ditches, sewers, culverts, pipes, conduits, drainage canals, tracks and similar structures. Regular pipe laying methods shall be used in all such cases except where special crossings are indicated.
- L. The Contractor shall not operate any valves that will allow water to flow or stop the flow of water. These valves will be operated by the Lafayette Utilities System personnel **only**.
- M. Water service to customers shall be maintained without interruption as much as possible. Interruption of service shall be allowed only at times agreed to by the Owner and with proper notice to the customer (at least one hour in advance).
- N. The Owner may require that major connections which require lengthy interruptions to service be made during periods of low water use or that temporary service lines be provided by the Contractor at no additional cost to the Owner.
- O. Assembly of fittings and other preparatory work shall be done in advance to reduce the off time and to keep interruption to a minimum.

3.05 BACKFILLING OF TRENCH

- A. Perform backfill operations and restore surface as soon as practicable. Leave only the minimum length of trench open as necessary for construction.
- B. Re-excavation of the trench for replacement of pipe, tapping, testing, or disinfecting shall be done by the Contractor at no additional cost to the Owner.
- C. The Owner reserves the right to order any trench or trenches backfilled at any time after installation of pipe if the particular trench remaining open constitutes a public nuisance.
- D. Outside of Public Right-of Ways:
 - 1. Compact excavated material around and to a depth of 12" above the pipe for the entire length of the trench to 90 percent of maximum standard proctor density in 6" to 8" lifts.
 - 2. The remaining portion of the trench shall be backfilled in 12" lifts and thoroughly compacted leaving a slightly crowned condition, not to exceed 12" above natural ground.
- E. Inside of Public Right-of-Ways: Outside of Public Roadways:
 - 1. Compact excavated material around and to a depth of 12" above the pipe for the entire length of the trench to 95 percent of maximum standard proctor density in 6" to 8" lifts.
 - 2. The remaining portion of the trench shall be backfilled in 12" lifts and thoroughly compacted leaving a slightly crowned condition, not to exceed 12" above natural ground.

Underneath roadways, streets, shoulders, walks, and drives (as per details in the drawings):

- 1. Limestone shall be compacted in 12" lifts to 95 percent density up to 3" (min.) -12" (max.) above pipe.
- 2. A mechanical vibrator shall be used to compact the limestone.
- 3. The remainder of the trench shall be filled with fill-crete (188 lbs. of cement, 3010 lbs. of sand, and 46.2 gals. of water).
- F. All excavated material shall be cleared from adjacent street surfaces, gutters, sidewalks, and lots. Salvaging and replacement of sod on lawns may be ordered by the Engineer at no additional cost to the Owner. All surplus excavated

material shall be removed by the Contractor, and shall be disposed of at locations and in a manner approved by the Engineer.

3.06 FLUSHING OF WATER MAIN

- A. As-built information shall be provided to LUS personnel prior to any flushing and testing.
- B. The flushing process shall be performed in the presence of LUS personnel. The Contractor shall notify LUS personnel at least 48 hours prior to flushing of the water mains.
- C. All water mains shall be flushed before testing and sampling of the water system.
- D. Provide properly sized riser pipes for flushing when hydrant outlets are not convenient. LUS personnel shall approve size of riser pipes for flushing.
- E. The duration of the flushing shall be determined in the field by the Engineer.
- F. The size of the flushing outlet shall be as shown below:

Water Main Size	Size of Flushing Outlet
2"	2" Riser
4"	2" Riser
6"	One 4 ¹ / ₂ " Hydrant Pumper Outlet or One 6" Riser
8"	One 4 ¹ / ₂ " Hydrant Pumper Outlet or One 6" Riser
10"	One 6" Riser
12"	One 8" Riser
16"	One 12" Riser

3.07 HYDROSTATIC TESTING OF MAINS

- A. The Contractor shall furnish all materials, equipment, and labor to satisfactorily test the pipe at no cost to Owner.
- B. The Owner shall supply water for testing purposes.
- C. The allowable leakage for push-on or mechanical joint ductile iron pipe per inch of diameter, per miles, per twenty-four (24) hour day, when tested at one hundred fifty (150) pounds per square inch pressure, shall not be more than ten point five (10.5) gallons, based on nominal lengths of eighteen (18) or twenty (20) feet.

3.08 DISINFECTION OF WATER LINES

- A. All water lines and appurtenances shall be disinfected before placing in service.
- B. Disinfection shall be performed in accordance with the latest revision of AWWA C651.
- C. A solution of calcium hypochlorite, sodium hypochlorite, or liquid chlorine shall be used to obtain a solution of at least 50 mg/l of available chlorine throughout the entire piping system.
- D. While the disinfectant is being applied to any section of the system, the water shall be allowed to flow at all extremities of the section until an orthotolidine test shows a deep orange color.
- E. Allow the chlorine solution to remain in the pipe for minimum of 24 hours. Then tests shall be performed to determine that a chlorine residual of at least 5 mg/l remains in the system.
- F. Repeat disinfection if chlorine residual is less than 5 mg/l.
- G. Following disinfection, the lines shall be thoroughly flushed to remove the chlorine.
- H. The Contractor shall be responsible to furnish taps, corporation stops, tubing, faucets, and labor to help obtain samples of water from the disinfected lines.
- I. The disinfection process shall be made in the presence of Lafayette Utilities System personnel. The Contractor shall notify LUS Personnel at least 48 hours prior to testing of the water lines.
- J. If bacteriological tests indicate that the water lines are not free of coliform organisms, the disinfection procedure shall be repeated on that part of the system until samples are proven to be free of contamination. Testing must be done by a laboratory that is certified by the State Health Officer.
- K. Disinfection shall be considered acceptable when reports indicate the lines are free of contamination and with the approval of the Engineer.
- L. The Contractor will be responsible for removing all testing and flushing risers within 5 working days after notice of clear sample.
- M. After all tests have been completed and risers removed, the corporation stops shall be plugged with a Mueller brass plug (No. H10033) or approved equal.

3.09 COOPERATING WITH LAFAYETTE UTILITIES SYSTEM (LUS)

- A. The source of water shall be the public water system operated by the Lafayette Utilities System.
- B. Connections to the water system shall be made in accordance with the plans and in cooperation with LUS personnel.

3.10 STORAGE OF MATERIALS

- A. All water main pipe and appurtenances shall be stored in an appropriate stock yard upon receipt by the Contractor and shall be secured so foreign and contaminating substances do not enter the water line materials.
- B. Pipe and fittings shall be placed on the job site only as needed and not in quantities greater than those to be installed in one working day.

3.11 CARE OF STREETS, SIDEWALKS & ROADS

- A. Remove all excess materials, debris or other obstruction from streets or roads immediately after completing backfilling, at Contractor's expense.
- B. Wash streets, sidewalks and roads daily to remove dust problem.
- C. No cross streets, sidewalks or roads shall be wholly obstructed except by written permission from the Engineer.
- D. If at any time the Contractor neglects to remove such material or obstruction and place streets, sidewalks and roads in suitable condition for traffic within twenty-four (24) hours after having received notice (written or verbal) from the Engineer, the work may be done by L.U.S., and the cost thereof charged to the Contractor and deducted from his final estimate.
- E. Repair and replace streets, sidewalks, roads, ditches and culverts to the satisfaction of the Engineer and parties concerned.

3.12 PROTECTION AND CARE OF PUBLIC OR PRIVATE PROPERTY AND SERVITUDES

- A. Continuously maintain and protect all underground and above ground structures, utilities, including the restoration of all public utilities, water mains, water services, gas mains, gas services, culverts, drains, ditches, curbs, sidewalks, landscaping and/or other facilities which may be damaged, to a condition at least equal to their original status, at no additional cost to L.U.S. In the event of damage to any facilities, the appropriate utility will be notified immediately. L.U.S. will repair damaged facilities at the Contractor's expense or require the Contractor to repair said damage.
- B. All construction work under this contract on servitudes, right-of-way, private property or franchise shall be confined to the limits of such servitudes, right-of-way or franchise. All work shall be accomplished so as to cause the least amount of disturbance and a minimum amount of damage.
- C. No trees or shrubbery shall be removed or trimmed without the consent of the Engineer. With such approval ornamental trees and shrubbery shall be carefully removed, with the earth surrounding their roots wrapped in burlap and replanted in their original positions within forty-eight (48) hours. All shrubbery or trees destroyed or damaged shall be replaced by the Contractor with material of equal quality at no cost to L.U.S.
- D. All obstacles such as fences, markers, mail boxes, driveway culverts, etc. shall be removed by the Contractor and immediately replaced after the trench is backfilled in their original position and condition at no direct cost to L.U.S.

E. Maintain adequate drainage during the process of construction.

3.13 CLEAN-UP

- A. Remove from the site all tools, equipment, temporary structures and surplus materials.
- B. Dispose of all excess soil, waste, rubbish, debris or objectionable materials off the site and in a manner and a location that complies with local ordinances and laws and is acceptable to all parties concerned and is approved by the Engineer.
- C. When disposal of excess soil is upon private lands, the Contractor shall be required to produce a written agreement with the private landowner stating the agreed terms and conditions.
- D. The entire construction site shall be left clean and to the satisfaction of the Engineer.

END OF SECTION

SECTION 02515

FIRE HYDRANTS, SERVICES, AND VALVES

PART I GENERAL

1.01 SECTION INCLUDES

A. The work covered by this section consists of furnishing all labor, equipment, appliances, materials, and all operations in connection with the installation of fire hydrants, services, and valves complete and in place, in accordance with the specifications and drawings.

1.02 REFERENCES

- A. AWWA C502 Dry-Barrel Fire Hydrants.
- B. AWWA C509 or C515 Resilient-Seated Gate Valves for Water and Sewerage Systems.
- C. AWWA C700 Cold Water Meters Displacement Type.
- D. AWWA C800 Underground Service Line Valves and Fittings.
- E. AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing.

1.03 QUALITY ASSURANCE

A. Submit a certificate of compliance from the manufacturer stating product meets standards as set forth in these specifications.

1.04 UNIT PRICES

- A. Method of Measurement:
 - 1. Fire Hydrant: Measured per each according to the type installed. Hydrant leads (pipe required in addition to typical hydrant installation) shall be measured and paid for as water main.
 - 2. Vertical Hydrant Extensions: Measurement shall be by the vertical foot actually installed.
 - 3. Service Connections: The following are the type of services available for installation per each.

- a. Type-A Service Connections Type-A service connections shall be measured at the unit price per each as bid for the various sizes.
- b. Type-B Service Connections Type-B service connections shall be measured at the unit price per each as bid for the various sizes. Measurement shall be the quantities actually installed, as described in the bid form and on the plans.
- c. Type-C Service Connections Type-C service connections shall be paid for at the unit price per each as bid for the various sizes. Measurement shall be the quantities actually installed, as described in the bid form and on the plans. Connection shall be paid for at the unit price per each as bid for the various sizes.
- d. Type-D Service Tap for Water Mains Four (4") Inches or Smaller: Type-D service taps shall be paid for at the unit price per each as bid for the various sizes. Measurement shall be the quantities actually installed as described in the bid form and on the plans.
- e. Type-E Service Taps for Water Mains Six (6") Inches or Larger: Type-E service taps shall be paid for at the unit price per each as bid for the various sizes. Measurement shall be the quantities actually installed as described in the bid form and on the plans.
- 4. Valves and Valve Boxes: Payment for valves and valve boxes shall be based on the actual number installed and shall be paid for at the contract price per each for the various size valves and valve boxes, such price to cover both valve and valve box and any necessary joint adapters for fitting the valves into the system.
- 5. Tapping Sleeves and Valves: Measurement shall constitute full compensation for furnishing the sleeves and valves, valve boxes, the labor, equipment, tools, materials, supplies, thrust blocks, anchors and other incidentals necessary for complete installation in accordance with these specifications and the contract drawings.
- 6. Cut-In Sleeves and Valves: Measurement of cut-in sleeves and valves shall be based on the number of each size actually installed and payment shall be at the unit price bid per each.
- 7. Polyethylene Tubing: Measurement of tubing shall be based on the actual linear foot installed and accepted.
- 8. Corporation Stops: Measurement shall be per each based on the quantities actually installed.
- B. Basis of Payment:
 - 1. Fire Hydrant: Paid for per each installed and accepted, according to type of installation, includes hydrant, anchoring fittings, labor, equipment, tools, materials, and supplies necessary to complete the hydrant installation.

- 2. Vertical Hydrant Extension: Paid for at the contract unit price per vertical foot including full compensation for furnishing all materials, tools, labor, equipment, and incidentals necessary to complete the installation.
- 3. Service Connections:
 - a. Type-A Service Connection: Connection shall be paid for at the unit price per each as bid for the various sizes.
 - b. Type-B Service Connection: Connection shall be paid for at the unit price per each as bid for the various sizes. Payment shall constitute full compensation for furnishing a new corporation stop and the labor, equipment, tools and incidentals necessary for changing the existing service from the old main to the new main.
 - c. Type-C Service Connection: Connection shall be paid for at the unit price per each as bid for the various sizes. Payment shall constitute full compensation for furnishing materials, labor, equipment, tools, supplies, and other incidentals necessary for complete installation of the service and valves from the main to the meter.
 - d. Type-D Service Tap for Water Mains 4" or Smaller: Connection shall be paid for at the unit price per each as bid for the various sizes. Payment shall constitute full compensation for furnishing and installing the corporation stop and strap.
 - e. Type-E Service Taps for Water Mains 6" or Larger: Connection shall be paid for at the unit price per each as bid for the various sizes. Payment shall constitute full compensation for furnishing the corporation stop.
- 4. Valves and Valve Boxes: Valves shall be paid for at contract unit price per each for the various size valves and valve boxes. Such payment shall constitute full compensation for furnishing the valves and valve boxes and for all labor, equipment, tools and supplies necessary for installation of the valves and valve boxes in accordance with these specifications and the drawings.
- 5. Tapping Valves and Sleeves: Payment of tapping sleeves and valves shall be based on the number of each size actually installed at the unit price bid per each which shall include all labor, equipment, tools and supplies necessary to complete the installation.
- 6. Cut-Valves and Sleeves: Payment of each size actually installed shall constitute full compensation for furnishing the sleeves and valves, valve boxes, the labor, equipment, tools, materials, supplies, thrust blocks, anchors and other incidentals necessary for complete installation in accordance with these specifications and the contract drawings.

- 7. Polyethylene Tubing: Paid for by the actual linear feet installed and accepted.
- 8. Corporation Stops: Paid for at the unit price per each as bid for the various sizes and types.

PART 2 PRODUCTS

2.01 FIRE HYDRANTS

- A. The fire hydrant shall conform to AWWA Standards C 502-94 or updated revisions thereof for improved type three-way dry barrel type hydrants. All hydrants must be UL and FM approved.
- B. Features:
 - 1. Operating nut must be:
 - a. Bronze.
 - b. Non-rising, pentagonal in shape, measuring 1-1/2" from point to flat.
 - 2. Hold-down nut must:
 - a. Incorporate an integral resilient weather seal.
 - b. Must be: counterclockwise.
 - 3. Lubrication chamber must be provided:
 - a. Sealed top and bottom with "O" rings.
 - b. Filled with lubricant which shall be either oil or grease.
 - c. The design shall be such that the thrust collar and the threaded operating parts are automatically lubricated each time the hydrant is cycled.
 - d. There must not be less than two (2) "O" rings separating the lubrications reservoir from the waterway and that portion of the stem contracting these "O" rings shall be sleeved with bronze.
 - e. An anti-friction device must be in place above the trust collar to further minimize operating torque.

- 4. Hydrants bonnet must be attached to the upper barrel by not less than four (4) bolts and nuts, with an inserted flat rubber gasket as a pressure seal.
- 5. Hydrants must be:
 - a. "Three-way", having two (2) 2-1/2" hose nozzles with National Standards Threads and one (1) pumper nozzle measuring 4-1/2"
 I.D. with National Standard Thread.
 - b. Nozzles must attach counterclockwise into hydrant barrel utilizing "O" ring pressure seals.
 - c. A suitable nozzle lock must be in place to prevent inadvertent nozzle removal.
 - d. "Traffic-model", having upper and lower barrels joined approximately 2" above the ground line by a separated and breakable "swivel" flange providing 360 degree rotation of upper barrel for proper nozzle facing. This flange must employ not less than eight (8) bolts.
 - e. Stem must be: two-piece, not less than 1-1/4" diameter or 1" x 1" square (excluding threaded or machined areas) and must be connected by a breakable stem coupling near the ground line flange. Screws, pins, bolts or fasteners used in conjunction with the stem coupling must be stainless steel.
 - f. Painted with Yellow Enamel #54-302 PPG or equal on exterior.
- 6. Hydrant shoe and barrel casting must be fabricated of ASTM, A-126, Class B Gray Iron or Ductile Iron ASTM, A1-536, but no combination thereof, assuring uniform strength of all cast components, minimizing the possibility of shoe breakage upon traffic impact. The inside diameter of the hydrant barrel shall not be less than six and one-eighth inches (6-1/8).
- 7. Main valves must be:
 - a. Compression type closing with the pressure and must be not less than 5-1/4" diameter.
 - b. Composition of the main valve must be molded rubber or neoprene, having a durometer hardness of 95 (+) (-) 5 and must be not less than 1" thick.

- 8. Hydrants must be equipped with drain valves which drain the barrel when the hydrant is closed and seal shut when the hydrant is open.
- 9. Seat ring and drain ring (show bushing) must be:
 - a. Bronze (ASTM B-62) and work in conjunction to form an all bronze drain way.
 - b. Two (2) drain openings are required and if they are in the cast iron shoe, they must be bronze lined and the bronze seat ring must thread into bronze drain ring (or shoe bushing) providing bronze to bronze connection.
 - c. Seat ring seals must be "O" rings. The 6" shoe connection must be specified (flanged, A/C, M.J., etc.) having ample blocking for sturdy setting and a minimum of eight (8) bolts and nuts is required to fasten the shoe to the lower barrel.
 - d. The interior of the shoe shall have a protective coating of a twopart thermosetting epoxy of at least 4 mils. If a stem cap nut is utilized it must be locked in place by a stainless steel lock washer or similar non-corrosive device.
- 10. Hydrant must have:
 - a. A working pressure rating of 250 PSIG and be tested at 500 PSIG.
 - b. Have a manufacture's warranty against defects in material or workmanship for a period of (5) years from date of manufacture.
- 11. Upon request, supplier must furnish flow data indicating friction loss in PSI at the flow of 1,000 GPM from the pumper nozzle. Such friction loss must not exceed 3 PSI.
- 12. Hydrant bury shall be three (3'), four (4'), five (5') and six (6') feet unless specified in bid form.
- 13. Hydrant extension sections shall be furnished by the same manufacturer as for the hydrant to which section is to be added.
- 14. One (1) hydrant wrench shall be furnished with each ten (10) hydrants or fraction thereof.
- 15. All nozzle caps shall have extra long, heavy (no smaller than five (5) gauge) link chains that will not kink. The chain loop at the cap end shall permit free turning of the caps.

- 16. a. Anchor couplings or swivel hydrant fittings shall be used where indicated on the drawings or where required by the Engineer to tie six (6") inch pipe from the main to the hydrant.
 - b. The three (3) types of anchoring fittings available are- anchoring tees, anchoring elbows and anchoring couplings.
 - c. Swivel mechanical joint hydrant fittings shall be made with AWWA Class "D" metal thickness throughout, with applicable dimensions, laying lengths and radii, conforming to AWWA A21.10 and AWWA C-111.
 - d. All anchoring tees shall be six (6") inch by six (6") inch by six (6") inch MJ by MJ by Swivel.
 - e. All anchoring elbows shall be six (6") inch by six (6") inch Swivel by Swivel ninety (90°) degree elbow.
 - f. All anchoring couplings shall be six (6") inch by six (6") inch Swivel by solid adapter twelve (12") long.
 - g. Acceptable manufacturers of anchor couplings: Tyler Pipe and Foundry Company, U.S. Pipe and Foundry Company, James B. Clow and Sons or approved equal.
- C. Acceptable manufacturers:
 - 1. Mueller A-423 "Centurion"
 - 2. M & H Dresser 929 "Reliant" or 129
 - 3. Kennedy K-81 "Guardian"
 - 4. Clow F2545 AMedallion≅
 - 5. American B-84-B

2.02 SERVICE CONNECTIONS

- A. Water Tubing (high density polyethylene): All high density polyethylene plastic tubing shall be SDR 9, Class 200 PSI, PE-3408 (Cell Class 355434-C) and shall conform to ASTM D2737-37, the latest amendment thereof. Stainless steel inserts (liners) are required on all connections to pack joint fittings.
- B. Corporation Stops: All corporation stops used shall conform to AWWA Standard C-800 and shall be Ford No. F-1000 or approved equal and shall be of the size required in the drawings.
- C. Curb Stops: Curb stops shall not be used unless such use is specifically requested and is approved by the Water Division. If required, these shall conform to AWWA Standards and shall be Ford Ball Valves or approved equal and shall be of the size required.

D. Meter Boxes: Cast iron meter boxes shall be sized by the Water Division and shall be of the following types or approved equal.

SIZE OF CO	NNECTIONS		
INLET	OUTLET	METER SIZE	TYPE
1"	1"	5/8" X 3/4"	Ford Yokebox No. YL 244-244
1"	1"	1"	Ford No. 4 Yokebox
2"	2"	1-1/2" & 2"	1/4" Cast Iron Box with 1/4" steel floor plate cover (Per Detail)

Meter boxes for meters up to and including 1" shall have pack joint fittings on each inlet and outlet connection and shall be coated with a coal tar type paint. Lids shall have "WATER METER" imprinted on them.

- E. Check Valves: All one (1") inch services shall use Stockman B-345 or approved equal. Check valves less than one (1") inch shall be used when determined by the Water Division or LCG Codes as necessary.
- F. Service Fittings: Brass goods and fittings shall be made of red brass of composition 85-5-5-5. All threads shall be standard in accordance with AWWA Standard C-800 for service fittings.

Pack joints for joining galvanized pipe, K copper and polyethylene plastic tubing PE 3408 shall be Ford Pack Joint Couplings or approved equal.

- G. Customer Shut-Off Valve: The customer shut-off valve shall be a gate valve type, Mueller H 10914, Nibco T-22 or approved equal. Body shall be of waterworks brass, tapped and threaded for iron pipe. Valves shall be a positive stop to prevent flow.
- H. Service Saddle Clamps: The service saddle clamps shall be as called for in the plans and/or bid form.

2.03 VALVES AND VALVE BOXES

- A. Gate valves shall be mechanical joint gate valves (four (4") inch through twelve (12") inch) having a resilient seat and shall conform to AWWA Specifications C509 or C515 and UL/FM approved.
- B. Design of gate valves four (4") inch through twelve (12") inch shall provide nonrising stem (NRS), dual seal between gate and body, smooth closing gate and one piece cast iron wedge with integral lugs. Valve shall be furnished with standard o-ring seals, two o-ring seals shall be set above the stem thrust collar and one below. Direction to open shall be counter-clockwise equivalent to American Flow 2500, M&H 4067-01 or 7571, Clow F6100 (C509 or C515) or Mueller A-2360.

- C. Valves for use with two (2") inch pipe shall be AWWA non-rising stem, iron body, resilient seat gate valves, similar to the type specified for larger sizes, except that the joints shall be screwed ends.
- D. Valves larger than twelve (12") inch shall be approved by LUS Civil Engineering Division.
- E. Valves shall be provided with two (2") inch operating nuts marked to indicate the direction of opening. Valves shall open counterclockwise.
- F. Valve boxes for all valves twelve (12") inch in diameter and smaller shall be made of cast iron and shall be of the heavy roadway type with inside diameter of not less than five (5") inches. The top section shall be adjustable for elevation. The base shall be sufficiently enlarged so that it will not come in contact with the valve or pipe at any point. All valve boxes shall be provided with covers on which the word "WATER" is printed in raised letters. A pre-cast concrete pad shall be installed for all valve boxes outside pavement.

2.04 TAPPING SLEEVES AND VALVES

- A. Mechanical joint type cast iron tapping sleeves and valves shall be used where indicated on the drawings or where required by the Engineer to make connections to existing four (4") inch and larger water mains.
- B. The tapping valves shall have a resilient seat and shall conform to AWWA Specifications C509 or C515. (Approved manufacturers: Kennedy, Clow, M&H, American Flow, or Mueller)
- C. For connecting to Class 150 asbestos cement pipe, stainless steel tapping sleeves shall be used. (Romac SST 304 stainless steel flange or approved equal)
- D. The tapping sleeves shall be Mueller No. H-615 or Kennedy 920; or Romac FTS 420, Smith-Blair 622 or Ford FTSC, epoxy coated with stainless steel nuts and bolts.

2.05 CUT-IN SLEEVES AND VALVES

- A. Cut-in valves shall be furnished with mechanical joints and shall installed within a valve box.
- B. Cut-in valves shall be Mueller H-866 or approved equal.
- C. Cut-in sleeves shall be Mueller H-842 or approved equal.

PART 3 EXECUTION

3.01 FIRE HYDRANT INSTALLATION

A. Install hydrants at locations indicated in the Drawings with pumper nozzles facing the street.

- B. Each hydrant shall be placed on a concrete base and shall be secured against dislocation, as indicated on the typical detail drawings.
- C. A minimum of seven (7) cubic feet of clean washed gravel shall be placed around each hydrant base. Backfill above gravel shall be thoroughly tamped.
- D. Bury hydrants to the point indicated on the barrel. Where necessary and where required by the Engineer, hydrant extension sections shall be installed to adjust the hydrant to grade.
- E. Fire hydrant bury shall be $3\frac{1}{2}$ ' for both 6" and 8" mains and $4\frac{1}{2}$ ' for 10" and above mains.
- F. Hydrants shall be installed plumb. Hydrants shall be properly lubricated and shall be in good working order before acceptance.
- G. Touch up painting will be required prior to acceptance.
- H. Fire hydrant leads (pipe required in addition to typical hydrant installation) will be classified as mains and will be paid for as such.

3.02 SERVICE CONNECTION INSTALLATION

A. Install service connections as detailed in the Drawings with all necessary connections, fittings, and appurtenances.

3.03 VALVE AND VALVE BOX INSTALLATION

- A. Valves shall be installed in locations shown on the plans or at locations designed by the Engineer.
- B. Installation of valves shall conform to the detail drawings or in accordance with manufacturer's instructions.
- C. All water valves shall be set vertically, unless otherwise directed by the Engineer.
- D. A concrete foundation shall be provided for each valve.
- E. Before being placed in the trench, all valves and fittings shall be carefully examined by the Contractor to assure that they are in good working order.
- F. A valve box shall be placed over each valve with the cover being placed level with the surface of the ground, finished street grade, or the elevation specified by the Engineer.
- G. The weight of the valve box shall not be supported by the valve or piping.

END OF SECTION 02515-10





FACTS

State of Louisiana Safe Drinking Water Program

Low lead requirements in plumbing and potable water distribution systems:

Concentrations of lead found in drinking water do not typically derive from natural sources. Instead, the most common cause of lead concentrations in potable water is contamination from the gradual corrosion of water supply pipes and plumbing fixtures as well as the solder, or flux, used for installation and repair. Most current regulatory efforts to control lead in drinking water focus primarily on reducing the lead content of these system components.

On June 29, 2011, Gov. Bobby Jindal signed Louisiana House Bill 471 and enacted Act Number 362. This Act takes effect January 1, 2013, and prohibits the use, installation, repair, introduction into commerce, or sale of pipes, fittings, fixtures, solder, or flux that are not "lead free" when used for conveying water for human consumption.

The Department of Health and Hospitals (DHH) has prepared this fact sheet to help clarify how Act 362 redefines "lead-free" and how these new, lowered lead limits will affect various components used in the construction of new and existing plumbing and water distribution projects. In addition, this fact sheet will describe the key components of implementation including code development, applicable performance and material standards, enforcement and exceptions.

Reduced Lead Requirements of Act 362 (effective January 1, 2013):

Under Act 362, the lead content of pipes, fittings and fixtures will be reduced from not more than 8.0 percent lead to not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures.

All pipe, plumbing fittings and fixtures, solder or flux used in the installation or repair of any public water system or any plumbing in a facility providing water for human consumption must meet the new low lead requirements, except when necessary for the repair of leaded joints of cast iron pipes. EXCEPTIONS: The following materials are not required to meet the reduced lead requirements of Act 362:

- Pipes, pipe fittings, plumbing fittings or fixtures, including backflow preventers, which are used exclusively for non-potable services such as manufacturing, fire sprinkler system, industrial processing, irrigation, outdoor watering or any other uses where the water is not anticipated to be used for human consumption; or
- Toilets, bidets, urinals, fill valves, flushometer valves, tub fillers, shower valves, showers, safety shower flushes, service saddles or water distribution main gate valves that are two inches in diameter or larger.
- Materials purchased or acquired by a public water system prior to January 1, 2013, can continue to be utilized until January 1, 2014.

In addition to the installation requirements, no person shall introduce into commerce any pipe, pipe or plumbing fitting or fixture intended to convey or dispense water for human consumption through drinking or cooking that is not lead-free, including kitchen faucets, bathroom faucets or any other enduse devices intended to convey or dispense water for human consumption through drinking or cooking.

Louisiana Administrative Code (LAC) Updates:

These new low-lead requirements will be published in Parts XII (Water Supplies) and XIV (Plumbing)

OVER



of LAC Title 51 (Sanitary Code). Under Parts XII and XIV, all applicable potable water piping, fixtures, pipe related products and materials that join or seal pipes shall be evaluated and listed as conforming with NSF/ ANSI 372-Drinking Water System Components, Lead Content or shall be certified to be lead-free by an independent American National Standards Institute (ANSI)-accredited third party testing laboratory, inspection agency or other organization concerned with product evaluation.

Enforcement:

The enforcement of the lead reduction law will be handled during plan reviews, permit inspections, surveys, complaints, etc. For plumbing-related violations, the enforcement will typically be handled at the local level in accordance with their ordinances, laws or other regulations. When handled at the state level, the enforcement process will be in accordance with Part I of LAC Title 51.

Potential Health Effects of Lead Exposure:

- Lead is a neuro-toxic metal that accumulates in both soft tissue and bones. Even low-level exposure can lead to a range of adverse health effects, including brain, nervous system and blood disorders.
- Children and Infants— Exposure can result in delays in physical or mental development, reduced intelligence, learning disabilities, attention deficit disorder, behavioral problems, stunted growth, impaired hearing and kidney damage.
- Adults— Exposure can result in kidney problems, high blood pressure, nerve disorders, fertility problems, muscle and joint pain, irritability, memory and concentration problems. Pregnant women can pass lead contained in their bodies to their fetuses.

Highlighted Facts:

- Act 362 Becomes Effective January 1, 2013.
- Prohibits the use, installation or repair, introduction into commerce, or selling of pipes, fittings, fixtures, solder, or flux that is not "lead-free" when used for conveying water for human consumption.
- Pipes, fittings and fixtures that are used exclusively for non-potable services are not required to meet the reduced lead requirements of Act 362.
- Materials purchased or acquired by a public water system prior to January 1, 2013 can continue to be utilized until January 1, 2014.
- All applicable piping, fixtures, pipe-related products and materials that join or seal pipes shall be evaluated and listed as conforming with NSF/ANSI 372-Drinking Water System Components, Lead Content or shall be certified to be lead free by an independent ANSIaccredited third party testing laboratory.

State of Louisiana Safe Drinking Water Program Department of Health and Hospitals Office of Public Health

628 N. 4th Street Baton Rouge, LA 70802

Phone: 225-342-7499 Fax: 225-342-7303 www.dhh.la.gov/SafeDrinkingWater
SECTION 000107 - SEALS PAGE

PRO ECT NUMBER: LCG PRO ECT NO. 1839 PRO ECT ADDRESS: 201 CAMELLIA BOULEVARD, LAFAYETTE, LA 70503

SPECIFICATIONS: THE FOLLOWING SPECIFICATION SECTIONS WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION:



SOUTHEAST ENGINEERS

030516 UNDERSLAB VAPOR BARRIER 032000 CONCRETE REINFORCING 033000 CAST-IN-PLACE CONCRETE 051200 STRUCTURAL STEEL FRAMING 053100 STEEL DEC ING 054000 COLD-FORMED METAL FRAMING 054400 COLD-FORMED METAL TRUSSES

SECTION 030516 - UNDERSLAB VAPOR BARRIER - STEGO

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sheet vapor barrier under concrete slabs on grade.

1.2 RELATED REQUIREMENTS

- A. Section 032000 Concrete Reinforcing.
- B. Section 033000 Cast-in-Place Concrete: Preparation of subgrade, granular fill, placement of concrete.

1.3 REFERENCE STANDARDS

- A. ASTM E1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs 2018a.
- B. ASTM E1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs 2017.

1.4 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products.
- C. Samples: Submit samples of underslab vapor barrier to be used.
- D. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Underslab Vapor Barrier:
 - 1. Water Vapor Permeance: Not more than 0.010 perms (0.6 ng/(s m2 Pa)), maximum.
 - 2. Complying with ASTM E1745 Class A.
 - 3. Thickness: 15 mils (0.4 mm).
 - 4. Basis of Design:
 - a. Stego Industries LLC; Stego Wrap Vapor Barrier (15-mil): www.stegoindustries.com/#sle.
 - b. Tex-Trude; Extreme Vapor Barrier (15-mil): www.textrude.com.
 - c. Substitutions: See Section 016000 Product Requirements.

B. Accessory Products: Vapor barrier manufacturer's recommended tape, adhesive, mastic, etc., for sealing seams and penetrations in vapor barrier.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surface over which vapor barrier is to be installed is complete and ready before proceeding with installation of vapor barrier.

3.2 INSTALLATION

- A. Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.
- B. Install vapor barrier under interior slabs on grade; lap sheet over footings and seal to foundation walls.
- C. Lap joints minimum 6 inches (150 mm).
- D. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.
- E. No penetration of vapor barrier is allowed except for reinforcing steel and permanent utilities.
- F. Repair damaged vapor retarder before covering with other materials.

SECTION 032000 - CONCRETE REINFORCING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

1.2 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete.
- B. Section 042000 Unit Masonry: Reinforcement for masonry.

1.3 REFERENCE STANDARDS

- A. ACI 301 Specifications for Concrete Construction 2020.
- B. ACI SP-66 ACI Detailing Manual 2004.
- C. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2022.
- D. ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2022.
- E. AWS B2.1/B2.1M Specification for Welding Procedure and Performance Qualification 2021.
- F. AWS D1.4/D1.4M Structural Welding Code Steel Reinforcing Bars 2018, with Amendment (2020).
- G. CRSI (DA4) Manual of Standard Practice 2018, with Errata (2019).

1.4 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
- C. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- D. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- E. Reports: Submit certified copies of mill test report of reinforcement materials analysis.

1.5 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301.1. Maintain one copy of each document on project site.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.4/D1.4M and no more than 12 months before start of scheduled welding work.

PART 2 PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa).
 - 1. Deformed billet-steel bars.
 - 2. Unfinished.
- B. Steel Welded Wire Reinforcement (WWR): Galvanized, deformed type; ASTM A1064/A1064M.
 - 1. Form: Flat Sheets.
 - 2. WWR Style: As indicated on drawings.
- C. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch (1.29 mm).
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

2.2 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) Manual of Standard Practice.
- B. Welding of reinforcement is permitted only with the specific approval of Enginee. Perform welding in accordance with AWS D1.4/D1.4M.

PART 3 EXECUTION

3.1 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor barrier.
- C. Comply with applicable code for concrete cover over reinforcement.

3.2 FIELD QUALITY CONTROL

A. An independent testing agency, as specified in Section 014000 - Quality Requirements, will inspect installed reinforcement for compliance with contract documents before concrete placement.

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete formwork.
- B. Cast-In-Place Concrete.
- C. oint devices associated with concrete work.
- D. Miscellaneous concrete elements, including equipment pads, equipment pits, and light pole bases.
- E. Concrete curing.

1.2 RELATED REQUIREMENTS

- A. Section 032000 Concrete Reinforcing.
- B. Section 033511 Concrete Floor Finishes: Densifiers, hardeners, applied coatings, and polishing.
- C. Section 079200 oint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.

1.3 REFERENCE STANDARDS

- A. ACI 117 Specification for Tolerances for Concrete Construction and Materials 2010 (Reapproved 2015).
- B. ACI 211.1 Selecting Proportions for Normal-Density and High Density-Concrete Guide 2022.
- C. ACI 301 Specifications for Concrete Construction 2020.
- D. ACI 302.1R Guide to Concrete Floor and Slab Construction 2015.
- E. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- F. ACI 305R Guide to Hot Weather Concreting 2020.
- G. ACI 306R Guide to Cold Weather Concreting 2016.
- H. ACI 308R Guide to External Curing of Concrete 2016.
- I. ACI 318 Building Code Requirements for Structural Concrete 2019 (Reapproved 2022).
- . ACI 347R Guide to Formwork for Concrete 2014 (Reapproved 2021).
- . ASTM C33/C33M Standard Specification for Concrete Aggregates 2018.

- L. ASTM C39/C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.
- M. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete 2022a.
- N. ASTM C109/C109M Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50 mm Cube Specimens) 2021.
- O. ASTM C143/C143M Standard Test Method for Slump of Hydraulic-Cement Concrete 2020.
- P. ASTM C173/C173M Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.
- Q. ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- R. ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete 2019, with Editorial Revision (2022).
- S. ASTM C618 Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete 2023.
- T. ASTM C827/C827M Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures 2016.
- U. ASTM C1107/C1107M Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) 2020.
- V. ASTM C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures 2020.
- W. ASTM C1602/C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete 2018.
- X. ASTM D1751 Standard Specification for Preformed Expansion oint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.
- Y. ASTM E1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs 2018a.
- Z. ASTM E1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs 2017.

1.4 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Mix Design: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 Concrete Mixtures.

- 2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 Concrete Quality, Mixing and Placing.
- 3. Indicate proposed mix design complies with admixture manufacturer's written recommendations.
- D. Samples: Submit samples of underslab vapor retarder to be used.
- E. Test Reports: Submit report for each test or series of tests specified.
- 1.5 QUALITY ASSURANCE
 - A. Perform work of this section in accordance with ACI 301 and ACI 318.1. Maintain one copy of each document on site.
 - B. Follow recommendations of ACI 305R when concreting during hot weather.
 - C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.1 FORMWOR

- A. Formwork Design and Construction: Comply with guidelines of ACI 347R to provide formwork that will produce concrete complying with tolerances of ACI 117.
- B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
 - 1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.
 - 2. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.

2.2 REINFORCEMENT MATERIALS

A. Comply with requirements of Section 032000.

2.3 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I Normal Portland type.
 1. Acquire cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C33/C33M.
 1. Acquire aggregates for entire project from same source.
- C. Fly Ash: ASTM C618, Class C or F.
- D. Calcined Pozzolan: ASTM C618, Class N.
- E. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
- F. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.4 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- D. Water Reducing Admixture: ASTM C494/C494M Type A.

2.5 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder:
 - 1. Sheet Material: ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single-ply polyethylene is prohibited.
 - 2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
 - 3. Products:
 - a. Stego Industries, LLC; ____: www.stegoindustries.com/#sle.
 - b. Tex-Trude, LP; Xtreme Vapor Barrier (15-mil): www.tex-trude.com/#sle.
 - c. Substitutions: See Section 016000 Product Requirements.
- B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Grout: Comply with ASTM C1107/C1107M.
 - 2. Height Change, Plastic State; when tested in accordance with ASTM C827/C827M:
 - a. Maximum: Plus 4 percent.
 - b. Minimum: Plus 1 percent.
 - 3. Minimum Compressive Strength at 48 Hours, ASTM C109/C109M: 2,000 pounds per square inch (13.7 MPa).
 - 4. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch (13.7 MPa).
 - 5. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: 7,000 pounds per square inch (48 MPa).
 - 6. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch (48 MPa).

2.6 BONDING AND OINTING PRODUCTS

- A. Slab Isolation oint Filler: 1/2 inch (13 mm) thick, height equal to slab thickness, with removable top section that will form 1/2 inch (13 mm) deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.

2.7 CURING MATERIALS

- A. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
 - 1. Product dissipates within 4 to 6 weeks.
 - 2. Products:
 - a. Euclid Chemical Company; COLOR-CRETE CURE AND SEAL VOC: www.euclidchemical.com/#sle.

- b. SpecChem, LLC; SpecRez: www.specchemllc.com/#sle.
- c. W. R. Meadows, Inc; 1100-Clear: www.wrmeadows.com/#sle.
- d. Substitutions: See Section 016000 Product Requirements.
- B. Water: Potable, not detrimental to concrete.

2.8 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
- D. Normal Weight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Water-Cement Ratio: Maximum 50 percent by weight.
 - 4. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 - 5. Maximum Slump: 4 inches (100 mm).
 - 6. Maximum Aggregate Size: 3/4 inch (19 mm).

2.9 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.
- B. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.2 PREPARATION

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

- D. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches (150 mm). Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
 - 1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.

3.3 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Architect not less than 24 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. Ensure reinforcement, inserts, and embedded parts will not be disturbed during concrete placement.
- F. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- G. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.4 SLAB OINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation oints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- D. Saw Cut Contraction oints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch (5 mm) thick blade and cut at least 1 inch (25 mm) deep but not less than one quarter (1/4) the depth of the slab.

3.5 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. Maximum Variation of Surface Flatness:
 - 1. Exposed Concrete Floors: 1/4 inch (6 mm) in 10 feet (3 m).
 - 2. Under Seamless Resilient Flooring: 1/4 inch (6 mm) in 10 feet (3 m).
 - 3. Under Carpeting: 1/4 inch (6 mm) in 10 feet (3 m).
- B. Correct the slab surface if tolerances are less than specified.
- C. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.6 CONCRETE FINISHING

- A. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch (6 mm) or more in height.
- B. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch (6 mm) or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
- C. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
 - 1. Surfaces to Receive Thick Floor Coverings: Wood float as described in ACI 302.1R; thick floor coverings include quarry tile, ceramic tile, and Portland cement terrazzo with full bed setting system.
 - 2. Surfaces to Receive Thin Floor Coverings: Steel trowel as described in ACI 302.1R; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
 - 3. Decorative Exposed Surfaces: Trowel as described in ACI 302.1R; take measures necessary to avoid black-burnish marks; decorative exposed surfaces include surfaces to be stained or dyed, pigmented concrete, surfaces to receive liquid hardeners, surfaces to receive dry-shake hardeners, surfaces to be polished, and all other exposed slab surfaces.
- D. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

3.7 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Surfaces Not in Contact with Forms:
 - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. eep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - a. Spraying: Spray water over floor slab areas and maintain wet.
 - 2. Final Curing: Begin after initial curing but before surface is dry.
 - a. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.

- D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- E. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain test samples for every 75 cubic yards (57 cu m) or less of each class of concrete placed.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.9 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.10 **PROTECTION**

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Structural steel framing members.
- B. Base plates, shear stud connectors and expansion joint plates.
- C. Grouting under base plates.

1.2 RELATED REQUIREMENTS

A. Section 053100 - Steel Decking: Support framing for small openings in deck.

1.3 REFERENCE STANDARDS

- A. AISC (MAN) Steel Construction Manual 2017.
- B. AISC 303 Code of Standard Practice for Steel Buildings and Bridges 2022.
- C. ASTM A36/A36M Standard Specification for Carbon Structural Steel 2019.
- D. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- E. ASTM A500/A500M Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.
- F. ASTM A563/A563M Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric) 2021a.
- G. ASTM A992/A992M Standard Specification for Structural Steel Shapes 2022.
- H. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- I. ASTM C827/C827M Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures 2016.
- . ASTM E94/E94M Standard Guide for Radiographic Examination Using Industrial Radiographic Film 2017.
- . ASTM E164 Standard Practice for Contact Ultrasonic Testing of Weldments 2019.
- L. ASTM E165/E165M Standard Practice for Liquid Penetrant Testing for General Industry 2018.
- M. ASTM E709 Standard Guide for Magnetic Particle Testing 2021.

- N. ASTM F436/F436M Standard Specification for Hardened Steel Washers Inch and Metric Dimensions 2019.
- O. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength 2020.
- P. ASTM F3125/F3125M Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2022.
- Q. AWS A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Examination 2020.
- R. AWS B2.1/B2.1M Specification for Welding Procedure and Performance Qualification 2021.
- S. AWS D1.1/D1.1M Structural Welding Code Steel 2020, with Errata (2022).
- T. RCSC (HSBOLT) Specification for Structural oints Using High-Strength Bolts; Research Council on Structural Connections 2020.
- U. SSPC-SP 3 Power Tool Cleaning 2018.

1.4 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - 2. Connections not detailed.
 - 3. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
- D. Fabricator Test Reports: Comply with ASTM A1011/A1011M.
- E. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- F. Designer's Qualification Statement.
- G. Fabricator's Qualification Statement.

1.5 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC (MAN) Steel Construction Manual.
- B. Maintain one copy of each document on site.
- C. Fabricator: Company specializing in performing the work of this section with minimum 10 years of documented experience.

- D. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.
- E. Erector: Company specializing in performing the work of this section with minimum 10 years of documented experience.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Steel Angles and Plates: ASTM A36/A36M.
- B. Steel W Shapes and Tees: ASTM A992/A992M.
- C. Rolled Steel Structural Shapes: ASTM A992/A992M.
- D. Cold-Formed Structural Tubing: ASTM A500/A500M, Grade B.
- E. High-Strength Structural Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, with matching compatible ASTM A563/A563M nuts and ASTM F436/F436M washers.
- F. Unheaded Anchor Rods: ASTM F1554, Grade 55, zinc coated, with matching ASTM A563/A563M nuts and ASTM F436/F436M Type 1 washers.
- G. Headed Anchor Rods: ASTM F1554 Grade 55, zinc-coated.
- H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- I. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch (13.7 MPa).
 - 2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch (48 MPa).
 - 3. Height Change, Plastic State; when tested according to ASTM C827/C827M:
 - a. Maximum: Plus 4 percent.
 - b. Minimum: Plus 1 percent.
 - . Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.
- . Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.2 FABRICATION

- A. Shop fabricate to greatest extent possible.
- B. Fabricate connections for bolt, nut, and washer connectors.

2.3 FINISH

A. Prepare structural component surfaces in accordance with SSPC-SP 3.

- B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, or in contact with concrete.
- C. Galvanize structural steel members indicated to comply with ASTM A123/A123M. Provide minimum 1.7 oz/sq ft galvanized coating. (Provide minimum 530 g/sq m galvanized coating.)

2.4 SOURCE QUALITY CONTROL

- A. High-Strength Bolts: Provide testing and verification of shop-bolted connections in accordance with RCSC (HSBOLT) Specification for Structural oints Using High-Strength Bolts, testing at least 10 percent of bolts at each connection.
- B. Welded Connections: Visually inspect all shop-welded connections and test at least 10 percent of welds using one of the following:
 - 1. Radiographic testing performed in accordance with ASTM E94/E94M.
 - 2. Ultrasonic testing performed in accordance with ASTM E164.
 - 3. Liquid penetrant inspection performed in accordance with ASTM E165/E165M.
 - 4. Magnetic particle inspection performed in accordance with ASTM E709.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.2 ERECTION

- A. Erect structural steel in compliance with AISC 303.
- B. Allow for erection loads and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Field weld components and shear studs indicated on shop drawings.
- D. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with RCSC (HSBOLT) Specification for Structural oints Using High-Strength Bolts .
- E. Do not field cut or alter structural members without approval of Architect.
- F. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.
- G. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.3 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

3.4 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 Quality Requirements.
- B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with RCSC (HSBOLT) Specification for Structural oints Using High-Strength Bolts, testing at least 10 percent of bolts at each connection.
- C. Welded Connections: Visually inspect all field-welded connections and test at least 10 percent of welds using one of the following:
 - 1. Radiographic testing performed in accordance with ASTM E94/E94M.
 - 2. Ultrasonic testing performed in accordance with ASTM E164.
 - 3. Liquid penetrant inspection performed in accordance with ASTM E165/E165M.
 - 4. Magnetic particle inspection performed in accordance with ASTM E709.

SECTION 053100 - STEEL DEC ING

PART 1 GENERAL

- 1.1 SECTION INCLUDES
 - A. Roof deck.
 - B. Supplementary framing for openings up to and including 18 inches (450 mm).

1.2 RELATED REQUIREMENTS

A. Section 051200 - Structural Steel Framing: Support framing for openings larger than 18 inches (450 mm) and shear stud connectors.

1.3 REFERENCE STANDARDS

- A. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.
- B. AWS B2.1/B2.1M Specification for Welding Procedure and Performance Qualification 2021.
- C. AWS D1.3/D1.3M Structural Welding Code Sheet Steel 2018, with Errata (2022).
- D. FM DS 1-28 Wind Design 2015, with Editorial Revision (2022).
- E. FM DS 1-29 Roof Deck Securement and Above-Deck Roof Components 2016, with Editorial Revision (2022).
- F. ICC-ES AC43 Acceptance Criteria for Steel Deck Roof and Floor Systems 2016.
- G. SDI (DM) Publication No.30, Design Manual for Composite Decks, Form Decks, and Roof Decks 2007.
- H. SSPC-Paint 20 Zinc-Rich Coating (Type I Inorganic, and Type II Organic) 2019.

1.4 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittals procedures.
- B. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.
- C. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
- D. Certificates: Certify that products furnished meet or exceed specified requirements.
- E. Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this Section approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Cut plastic wrap to encourage ventilation.
- B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Steel Deck:
 - 1. Nucor-Vulcraft Group; ____: www.vulcraft.com/#sle.
 - 2. New Millenium; www.newmill.com.
 - 3. Substitutions: See Section 016000 Product Requirements.

2.2 STEEL DEC

- A. Roof Deck: Non-composite type, fluted steel sheet:
 - 1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 50/340, Class 1, 2, or 4, with G90/Z275 galvanized coating.
 - 2. Structural Properties:
 - a. Span Design: Multiple.
 - 3. Minimum Base Metal Thickness: 22 gauge, 0.0299 inch (0.76 mm).
 - 4. Nominal Height: 1-1/2 inch (38 mm).
 - 5. Profile: Fluted; SDI NR.
 - 6. Formed Sheet Width: 36 inch (900 mm).
 - 7. Side oints: Lapped, mechanically fastened.
 - 8. End oints: Lapped, mechanically fastened.

2.3 ACCESSORY MATERIALS

- A. Fasteners: Galvanized hardened steel, self tapping.
- B. Mechanical Fasteners: Steel; hex washer head, self-drilling, self-tapping.
 - 1. Design Requirements for Sidelap Connections: Provide number and type of fasteners that comply with the applicable requirements of SDI (DM) design method for roof deck and floor deck applications, ICC-ES AC43, and FM DS 1-28 wind uplift resistance.
 - 2. Products:
 - a. ITW Commercial Construction North America; ITW CCNA-Buildex Teks Select Series; _____: www.ITWBuildex.com/#sle.
 - b. Substitutions: See Section 016000 Product Requirements.
- C. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, complying with VOC limitations of authorities having jurisdiction.

2.4 FABRICATED DEC ACCESSORIES

A. Sheet Metal Deck Accessories: Metal closure strips and cover plates, 22 gauge, 0.0299 inch (0.76 mm) thick sheet steel; of profile and size as indicated; finished same as deck.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to beginning work.

3.2 INSTALLATION

- A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.
- B. On steel supports provide minimum 1-1/2 inch (38 mm) bearing.
- C. Fasten deck to steel support members at ends and intermediate supports at as indicated, parallel with the deck flute and at each transverse flute using methods specified.
- D. At mechanically fastened male/female side laps fasten at 8 on center maximum.
- E. Drive mechanical sidelap connectors completely through adjacent lapped sheets; positively engage adjacent sheets with minimum three-thread penetration.
- F. Weld deck in accordance with AWS D1.3/D1.3M.
- G. At deck openings from 6 inches (150 mm) to 18 inches (450 mm) in size, provide 2 by 2 by 1/4 inch (50 by 50 by 6 mm) steel angle reinforcement. Place angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and fusion weld to deck at each flute.
- H. At deck openings greater than 18 inches (450 mm) in size, provide steel angle reinforcement. as specified in Section 051200.
- I. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Formed steel stud exterior wall and interior wall framing.
- B. Exterior wall sheathing.
- C. Water-resistive barrier over sheathing.

1.2 RELATED REQUIREMENTS

A. Section 054400 - Cold-Formed Metal Trusses.

1.3 DEFINITIONS

- A. General: See AISI S240 for definitions of terms used in this section.
- B. Connection: A combination of structural elements and joints used to transmit forces between two or more members.
- C. Connector: A device used to transmit forces between cold-formed steel structural members or between a cold-formed steel structural member and another structural element.

1.4 REFERENCE STANDARDS

- A. AISI S201 North American Standard for Cold-Formed Steel Framing Product Data 2017.
- B. AISI S240 North American Standard for Cold-Formed Steel Structural Framing 2015, with Errata (2020).
- C. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- D. ASTM A780/A780M Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings 2020.
- E. ASTM A1003/A1003M Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members 2015.
- F. ASTM C1007 Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories 2020.
- G. ASTM C1177/C1177M Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing 2017.
- H. ICC-ES AC38 Acceptance Criteria for Water-Resistive Barriers 2016, with Editorial Revision (2019).

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other sections that is to be installed in or adjacent to metal framing systems, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by affected installers.

1.6 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on cold-formed steel structural members; include material descriptions and base steel thickness.
- C. Product Data: Provide manufacturer's data on factory-made connectors and mechanical fasteners, showing compliance with requirements.
- D. Product Data: For lateral-force resisting systems, provide product data sheets on hold-down, showing compliance with requirements.
- E. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, and type and location of fasteners, and accessories or items required of related work.
 - 1. Indicate stud layout.
 - 2. Describe method for securing studs to tracks and for bolted framing connections.
- F. Steel Framing Industry Association (SFIA) Certification:
 - 1. Submit documentation that metal studs and connectors used on project meet or exceed requirements of International Building Code.
- G. Design Data:
 - 1. Shop drawings signed and sealed by a professional structural engineer.
 - 2. Design calculations sufficient to demonstrate compliance with design criteria; signed and sealed by a professional structural engineer.
 - 3. Details and calculations for factory-made connectors, signed and sealed by a professional structural engineer.
- H. Evaluation Service Reports: Provide reports indicating compliance with specified requirements for cold-formed steel structural members.
- I. Inspection Reports: Provide material verification Inspection Reports in accordance with requirements of AISI S240.
- . Inspection Reports: Provide Inspection Reports for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240.
- . Manufacturer's Installation Instructions: Provide installation instructions for connectors.
- L. Installation Drawings: Indicate dimensioned locations of cold-formed steel structural framing.
 1. Include materials.
- M. Designer's Qualification Statement.

- N. Manufacturer's Qualification statement.
- O. SSMA Manufacturer Qualification: Submit documentation of manufacturer association membership.
- P. Testing Agency Qualification statement.
- 1.7 QUALITY ASSURANCE
 - A. See Section 014000 Quality Requirements for additional requirements.
 - B. Designer Qualifications: Design framing system under direct supervision of a professional structural engineer experienced in designing this work and licensed in the State in which the Project is located.
 - C. SFIA Code Compliance Certification Program: www.CFsteel.org/#sle: Use metal studs and connectors certified for compliance with International Building Code.
 - D. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.
 - E. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.
 - F. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Structural Framing:
 - 1. CEMCO; ____: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich; ____: www.clarkdietrich.com/#sle.
 - 3. MarinoWARE; ____: www.marinoware.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.

B. Connectors:

- 1. ClarkDietrich; ____: www.clarkdietrich.com/#sle.
- 2. Simpson Strong-Tie; : www.strongtie.com/#sle.
- 3. Substitutions: See Section 016000 Product Requirements.
- 2.2 Performance Requirements
 - A. Comply with requirements for Contractor's design-related professional design services indicated in Section 014000 Quality Requirements.
 - B. Design Criteria: As indicated on the drawings.
 - 1. Floor Live Loads:
 - a. Minimum Uniformly Distributed: 50 psf (244 kg/sq m).
 - b. Minimum Concentrated: 1,000 lbs (454 kg).
 - 2. Roof Live Loads:

- a. Minimum Uniformly Distributed: _____ psf (_____ kg/sq m).
- b. Minimum Concentrated: _____psf (_____kg/sq m).
- 3. Wind Loads: _____psf (_____kPa) positive and _____psf (_____kPa) negative.
- 4. Live load deflection meeting the following, unless otherwise indicated:
 - a. Floors: Maximum vertical deflection under live load of 1/480 of span.
 - b. Roofs: Maximum vertical deflection under live load of 1/240 of span.
 - c. Exterior Walls: Maximum horizontal deflection under wind load of 1/600 for brick veneer finishes and 1/360 for all other finishes.
 - d. Design nonaxial loadbearing framing to accommodate not less than 3/4 in (19 mm) vertical deflection.
- 5. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
- 6. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.3 MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.

2.4 STRUCTURAL FRAMING COMPONENTS

- A. Wall Studs and Track Sections: AISI S240; c-shaped studs and u-shaped track sections in studmatching nominal width and compatible height.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Thickness and Depth: As indicated on drawings.

2.5 LATERAL FORCE-RESISTING SYSTEMS

- A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: CP 90 in accordance with AISI S240.

B. Curtain Wall Studs and Girts:

- 1. Thickness and Depth: Depth as indicated on the drawings; thickness and structural grade as required to meet design criteria.
- 2. Thickness: 43 mils, 0.0428 inch (1.087 mm), minimum.
- 3. Depth: _____ inches (_____ mm).

2.6 CONNECTIONS

- A. Performance Requirements: Provide connections in compliance with requirements of AISI S240.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: CP 90 in accordance with AISI S240.

- C. Structural Performance: Maintain load and movement capacity required by applicable building code and specified design criteria.
- D. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
 - 1. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical movement of slab without affecting studs; allow for minimum movement of 3/4 inch.
 - 2. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 10 feet (3048 mm).
- E. Fixed Connections: Provide nonmovement devices for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.
 - 1. Products:
 - a. Simpson Strong-Tie; ____: www.strongtie.com/#sle.
 - b. Clark Dietrich; www.clarkdietrich.com.
 - c. Substitutions: See Section 016000 Product Requirements.
- F. Bridging Connections: Provide mechanical load-transferring devices that accommodate wind load torsion and weak axis buckling induced by axial compression loads. Provide bridging connectors where indicated on the drawings.
- G. Products:
 - 1. ClarkDietrich; FastBridge Clip: www.clarkdietrich.com/#sle.
 - 2. Simpson Strong-Tie; SUBH Bridging Connector: www.strongtie.com/#sle.
 - 3. Substitutions: See Section 016000 Product Requirements.
- 2.7 Miscellaneous Connections
 - A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot-dip galvanized per ASTM A153/A153M.
 - 1. Products:
 - a. ITW Commercial Construction North America; ITW CCNA-Buildex Teks Select Series; _____: www.ITWBuildex.com/#sle.
 - b. Substitutions: See Section 016000 Product Requirements.
 - B. Anchorage Devices: Powder actuated.

2.8 SHEATHING

- A. Glass-mat-faced gypsum board; ASTM C1177/C1177M, square long edges, 5/8 inch (15.9 mm) thick, Type X fire-resistant.
- 2.9 ACCESSORIES
 - A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
 - B. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780/A780M.

C. Water-Resistive Barrier: ICC-ES AC38 Grade D and 60-minute plastic sheet.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.2 PREPARATION

- A. Structural Wall Foundations: For gaps between wall bottom track and top of foundation 1/4 inch (6.4 mm) or greater, level substrate with loadbearing shims or grout between track and foundation.
- 3.3 Installation General
 - A. Install structural members and connections in compliance with AISI S240.

3.4 INSTALLATION OF STUDS

- A. Install wall studs plumb and level.
- B. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- C. Install load-bearing studs full length in one piece. Splicing of studs is not permitted.
- D. Install load-bearing studs; brace, and reinforce to develop full strength and achieve design requirements.
- E. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- F. Install intermediate studs above and below openings to align with wall stud spacing.
- G. Provide deflection allowance in stud track, directly below horizontal building framing at nonloadbearing framing.
- H. Attach cross studs to studs for attachment of fixtures anchored to walls.
- I. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- . Touch-up field welds and damaged corrosion-protected surfaces zinc-rich paint in compliance with ASTM A780/A780M.
- . Touch-up field welds and damaged corrosion protected surfaces with primer.

3.5 INSTALLATION OF OISTS and PURLINS

3.6 INSTALLATION OF WALL SHEATHING

- A. Install wall sheathing with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
 - 1. Place water-resistive barrier horizontally over wall sheathing, weather lapping edges, and ends.

3.7 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Provide material verification inspections in accordance with requirements of AISI S240.
- C. Provide inspections for mechanical fastening and cold-formed steel light-frame construction in accordance with requirements of AISI S240.

3.8 TOLERANCES

- A. Studs Vertical Alignment (Plumbness): 1/960 of span or 1/8 inch in 10 ft (3.2 mm in 3000 mm), in accordance with ASTM C1007.
- B. Studs Maximum Variation from True Position: 1/8 inch (3.2 mm) in accordance with ASTM C1007.
- C. Stud Spacing: 1/8 inch (3.2 mm) from the designated spacing, provided that the cumulative error does not exceed the requirements of the finishing materials in accordance with ASTM C1007.

SECTION 054400 - COLD-FORMED METAL TRUSSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Light gauge cold-formed steel roof trusses.
- B. Anchorages, bracing, and bridging.

1.2 RELATED REQUIREMENTS

A. Section 054000 - Cold-Formed Metal Framing: Light gauge structural metal studs, joists, and rafters.

1.3 REFERENCE STANDARDS

- A. AISI S100 North American Specification for the Design of Cold-Formed Steel Structural Members 2016, with Supplement (2020).
- B. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.
- C. ASTM A780/A780M Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings 2020.
- D. AWS B2.1/B2.1M Specification for Welding Procedure and Performance Qualification 2021.
- E. AWS D1.1/D1.1M Structural Welding Code Steel 2020, with Errata (2022).
- F. AWS D1.3/D1.3M Structural Welding Code Sheet Steel 2018, with Errata (2022).
- G. CFSEI 5000 Field Installation Guide for Cold-Formed Steel Roof Trusses May 2000.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meeting: Meet at project site prior to beginning of installation to review requirements. Require attendance by representatives of the following:
 - 1. Truss fabricator.
 - 2. Truss installer.
 - 3. Other entities affected by the work of this section, including but not limited to truss support framing installer, mechanical systems installer, and electrical systems installer.

1.5 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Span charts.
 - 2. Storage and handling requirements and recommendations.

- 3. Installation methods.
- C. Shop Drawings:
 - 1. Include detailed roof truss layout.
 - 2. Show member type, location, spacing, size and gauge, methods of attachment, and erection details. Indicate supplemental bracing, strapping, splices, bridging, and accessories.
 - 3. Include truss design drawings, signed and sealed by a qualified professional engineer registered in the State in which the Project is located, verifying ability of each truss design to meet applicable code and design requirements.
 - a. Include the following:
 - 1) Design criteria.
 - 2) Engineering analysis depicting member stresses and deflections.
 - 3) Member sizes and gauges.
 - 4) Details of connections at truss joints.
 - 5) Truss support reactions.
 - 6) Bracing requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention.
- E. Designer's Qualification Statement.
- F. Fabricator's Qualification Statement.
- G. Installer's Qualification Statement.
- H. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated within the previous 12 months.

1.6 QUALITY ASSURANCE

- A. Designer Qualifications: Design trusses under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. Fabricator Qualifications: Steel truss fabricator with minimum 10 years of experience designing and fabricating truss systems equivalent to those required for this project and licensed by an acceptable manufacturer.
- C. Installer Qualifications: Experienced installer approved by truss system fabricator.
- D. Welder Qualifications: Welding processes and welding operators qualified within previous 12 months in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver trusses and other materials in manufacturer's unopened bundles or containers, each marked with manufacturer's name, brand, type, and grade. Exercise care to avoid damage during unloading, storing, and erection.
- B. Store trusses on blocking, pallets, platforms, or other supports, off the ground and in an upright position, sufficiently braced to avoid damage from excessive bending. Gently slope stored trusses to avoid accumulation of water on interior of truss chord members.

C. Protect trusses and accessories from contact with earth, corrosion, deformation, mechanical damage, or other deterioration when stored at project site.

PART 2 PRODUCTS

2.1 **MANUFACTURERS**

- A. Cold-Formed Steel Trusses:
 - Aegis Metal Framing, a Division of MiTek Industries; : 1. www.aegismetalframing.com/#sle.
 - 2. Alpine TrusSteel, an ITW Company Inc; : www.trussteel.com/#sle.
 - Substitutions: See Section 016000 Product Requirements. 3.

2.2 TRUSS DESIGN REQUIREMENTS

- A. Design: Calculate structural characteristics of cold-formed steel truss members according to AISI \$100.
- B. Structural Performance: Design, engineer, fabricate, and erect trusses to withstand specified design loads for project conditions within required limits.
 - Design Loads: As indicated on drawings. 1.
 - a. Roof Live Loads:
 - Minimum Uniformly Distributed:
 ______ psf (______ kg/sq).

 Minimum Concentrated:
 ______ psf (______ kg/sq).

 1)
 - 2)
 - Wind Load: psf (kg/sq). 3)
 - 2. Deflections: Live load deflection meeting the following, unless otherwise indicated:
 - Roofs: Maximum vertical deflection under live load of 1/240 of span. a
 - Design trusses to accommodate movement attributable to temperature changes within a 3. range of 120 degrees F (67 degrees C) without damage or overstressing, sheathing failure, undue strain on fasteners and anchors, or other deleterious effects.

2.3 **COMPONENTS**

- A. Trusses: Light gauge steel assemblies providing a complete horizontal framing system for locations indicated, ready for deck installation.
 - Truss Type, Span, and Height: As indicated on drawings. 1.
 - 2 Chord and Web Members: Fabricate required shapes from commercial quality galvanized steel sheet complying with ASTM A653/A653M, with minimum yield strength of 40,000 psi (275 MPa); minimum G60/Z180 coating; gauges as required for load conditions; all edges rolled or closed.
- Fasteners: Self-drilling, self-tapping screw fasteners with corrosion-resistant plated finish, as B. recommended by steel truss manufacturer and marked for easy identification.
 - Welding: Comply with applicable provisions of AWS D1.1/D1.1M and AWS 1. D1.3/D1.3M.
- C. Bracing, Bridging, and Blocking Members: Fabricate required shapes from commercial quality galvanized steel sheet complying with ASTM A653/A653M, with minimum yield strength of 33,000 psi (230 MPa); minimum G60/Z180 coating; gauges as required for load conditions.

2.4 FABRICATION

- A. Factory fabricate cold-formed steel trusses plumb, square, true to line, and with secure connections, complying with manufacturer's recommendations and project requirements.
 - 1. Fabricate trusses using jig templates.
 - 2. Cut truss members by sawing, shearing, or plasma cutting.
 - 3. Fasten members in full compliance with instructions of manufacturer. Wire tying of framing members is not permitted.
- B. Tolerances: Fabricate trusses to maximum allowable tolerance variation from plumb, level and true line of 1/8 inch in 10 feet (1:1000).
 - 1. Up to 30 feet (9 m) Long: Maximum plus or minus 1/2 inch (12 mm) from design length.
 - 2. Over 30 feet (9 m) Long: Maximum plus or minus 3/4 inch (19 mm) from design length.
 - 3. Up to 5 feet (1.5 m) High: Maximum plus or minus 1/4 inch (6 mm) from design height.
 - 4. Over 5 feet (1.5 m) High: Maximum plus or minus 1/2 inch (12 mm) from design height.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine structure, substrates, and installation conditions. Notify Architect of unsatisfactory preparation. Do not begin installation until substrates have been properly prepared and unsatisfactory conditions have been corrected.
- B. Proceeding with installation indicates installer's acceptance of substrate conditions.

3.2 INSTALLATION

- A. Install cold-formed steel trusses in strict accordance with manufacturer's instructions and approved shop drawings, using approved fastening methods.
- B. Install temporary erection bracing and permanent bracing and bridging before application of any loads. Erect trusses with plane of truss webs vertical and parallel to each other, accurately located at spacing indicated. Anchor trusses securely at bearing points.
- C. Adequately distribute applied loads to avoid exceeding the carrying capacity of any one joint, truss, or other component.
- D. Exercise care to avoid damaging truss members during lifting and erection and to minimize horizontal bending of trusses.
- E. Removal, cutting, or alteration of any truss chord, web, or bracing member in the field is prohibited, unless approved in advance by Architect or the engineer of record and the truss manufacturer.
- F. Repair or replace damaged members and complete trusses as directed and approved in writing by Architect or the engineer of record and the truss manufacturer.
- G. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780/A780M.

- H. Field Welding: In accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M, as applicable, and as follows:
 - 1. Connections: Provide fillet, flat, plug, or butt welds, as indicated on shop drawings.
 - 2. Minimum steel thickness for welded connections, 18 gauge, 0.0478 inch (1.21 mm).
- I. Roof Trusses:
 - 1. Comply with recommendations of CFSEI 5000.
 - 2. Align truss bottom chords with load-bearing studs or continuously reinforce track as required to transfer loads to structure.
 - 3. Install continuous bridging and permanent truss bracing as indicated.
 - 4. Install roof cross bracing and diagonal bracing as indicated.

3.3 TOLERANCES

- A. Install trusses to maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet (1:1000).
- B. Space individual trusses not more than plus or minus 1/8 inch (3.2 mm) from plan location. Cumulative error in placement may not exceed minimum fastening requirements of sheathing or other material fastened to trusses.

3.4 FIELD QUALITY CONTROL

A. Owner will provide inspection service for inspection of field connections, in accordance with requirements of Section 014000 - Quality Requirements.

3.5 **PROTECTION**

- A. Protect trusses from damage by subsequent construction activities.
- B. Repair or replace damaged trusses, truss members, and bracing members; obtain approval in advance by Architect or the engineer of record and the truss manufacturer for all cutting, repairs, and replacements.
| PROJECT NAME: | Lafayette Fire Station
Lafayette, LA | 6 |
|---------------|---|----------|
| ARCHITECT: | Trahan Architecture | Planning |
| PROJECT NO.: | 22034.00 | |

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- 23 90 20 Temperature Controls

Electrical Specifications:

DIVISION 26 – ELECTRICAL

- 26 05 00 Common Work Results for Electrical
- 26 05 19 Low-Voltage Electrical Power Conductors and Cables
- 26 05 26 Grounding and Bonding for Electrical Systems
- 26 05 29 Hangers and Supports for Electrical Systems
- 26 05 33 Raceways and Boxes for Electrical Systems
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- 26 24 16 Panelboards
- 26 27 26 Wiring Devices
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- 26 43 13 Surge Protection Device for Service Entrance and Branch Panels
- 26 51 00 Interior Lighting
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DIVISION 27 – COMMUNICATIONS

- 27 05 36 Cable Trays and Communications Systems
- 27 13 00 Voice and Data System

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

28 31 11 Fire Alarm

Section 21 13 13 - Wet-Pipe Sprinkler Systems

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Cover system for sprinkler piping.
 - 3. Specialty valves.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Control panels.
 - 7. Pressure gages.

- DUSTIN W. DUVAL REG. No. 37235 PROFESSION FLORER UNCAL ENGINE
- B. FURNISH ALL MATERIALS, LABOR, TOOLS, EQUIPMENT AND WOR ING PLANS TO INSTALL AND PLACE INTO OPERATION THE COMPLETE FIRE PROTECTION SYSTEM (AUTOMATIC WET PIPE SPRIN LER SYSTEM) FOR THE ENTIRE BUILDING IN ACCORDANCE WITH THE ATTACHED PLANS AND AS SPECIFIED HEREIN.
- C. All work shall meet requirements of the latest edition of the National Fire Protection Association (NFPA), Louisiana State Fire Marshal.
- D. Prior to start of the design of the fire protection system, the contractor shall coordinate and complete the "Owner's Information Certificate" form required by the State Fire Marshal. The form can be found at the State Fire Marshal's website <u>http://www.dps.louisiana.gov/sfm.</u> The form shall identify special occupancies and commodity classifications and shall be given to the fire protection system designer before the start of design.
- E. Sprinkler contractor shall visit site and familiarize himself with all existing conditions, examine plans and specifications to determine building conditions and coordinate with work being performed by other trades. Contractor shall make note that all calculations and plans required by the State Fire Marshal shall be provided by Sprinkler Contractor.
- F. Each bidder shall be licensed to perform sprinkler work in the State of Louisiana and shall be recognized by Property Insurance Association of Louisiana as a reliable sprinkler contractor.
- G. Sprinkler Contractor shall include in his price all offsets required in order to avoid conflict with ductwork, lights, grilles, air boxes, etc. All offsets shall be made above intersecting ducts or pipes in order to minimize trapping of water. Contractor shall coordinate installation of his piping with all other trades to assure that they can all fit in the space provided. In general, sprinkler piping shall be run at maximum height above finished floor or between joists in order to minimize conflict with different trades. In areas where joists are exposed, lines shall be run at bottom of roof deck, between or through joists.

- H. Contractor shall make note that sprinkler piping layout and sprinkler head locations are diagrammatic and all spaces shall have proper number of heads and proper pipe size in contractor's price.
- I. Contractor shall also obtain latest flow data for local utility company and assure himself prior to bid that adequate pressures and flow are available for the system he intends to provide.

1.3 REQUEST FOR APPEAL

- A. The Contractor shall be required to complete any and all "Appeals" to the State Fire Marshal's Office required to clear review comments associated with shop drawings. The Contractor shall be required to complete the Appeal Forms and provide associated appeal costs for appeals associated with the project.
 - 1. Example of Appeals including but not limited to: Sprinkler head type below stands, Low Suction Control Valve required by DHH on Fire Pump applications, etc.

1.4 DEFINITIONS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Shop drawings shall be prepared by the contractor before commencing fire protection installation. The shop drawings shall be detailed as required by the State Fire Marshal's Office and submitted through the Architect to the following for approval:
 - a. State Fire Marshal.
 - b. Local Fire Prevention Bureau.
 - 4. Provide review application fee as required by the State Fire Marshal. Contractor shall pay all applicable fees required for the project thru completion of project.
 - 5. All shop drawings plans and elevations shall be made at 1/8" scale and arranged same as contract drawings.
 - 6. Provide scaled site plan.
- C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed by the qualified NICET certified designer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
- B. Qualification Data: For qualified Installer and NICET designer.

- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Fire-hydrant flow test report.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include Contractor's Material and Test Certificate for Aboveground Piping.
- F. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

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

1.9 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified designer.
 - b. The contractor shall be a qualified fire protection contractor, licensed by the State of Louisiana and directly engaged in the installation of automatic fire sprinkler systems and other fire protection equipment.
- B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.10 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 1. NFPA 13.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Engage a qualified designer to design wet-pipe sprinkler systems.
 - 1. Conduct a fire-hydrant flow test and indicate the following conditions:
 - a. Date:
 - b. Time:
 - c. Performed by:
 - d. Location of Residual Fire Hydrant R:
 - e. Location of Flow Fire Hydrant F:
 - f. Static Pressure at Residual Fire Hydrant R:
 - g. Measured Flow at Flow Fire Hydrant F:
 - h. Residual Pressure at Residual Fire Hydrant R:
 - 2. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications as per NFPA.
 - 3. Minimum Density for Automatic-Sprinkler Piping Design as per NFPA:
 - 4. Maximum Protection Area per Sprinkler: According to UL listing.

2.2 STEEL PIPE AND FITTINGS

- A. Standard-Weight, SCHEDULE 40 Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized- and Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.
- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - Pipe-Flange Gasket Materials: EPDM rubber gasket.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

1.

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

2.3 SPECIALTY VALVES

A. Listed in UL's Fire Protection Equipment Directory or FM Global's Approval Guide.

B. Pressure Rating:

- 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.

2.4 SPRIN LERS

- A. Manufacturers shall be one of the following:
 - 1. Viking Corporation.
 - 2. Reliable Automatic Sprinkler Co.
 - 3. Grinnel.
 - 4. Tyco Fire Building Products.
- B. Listed in UL's Fire Protection Equipment Directory or FM Global's Approval Guide.
- C. Pressure Rating for Residential Sprinklers: 175-psig maximum.
- D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- E. Automatic Sprinklers with Heat-Responsive Element:
 - 1. Early-Suppression, Fast-Response Applications: UL 1767.
 - 2. Nonresidential Applications: UL 199.
 - 3. Residential Applications: UL 1626.
 - 4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient of 5.6, and for Ordinary temperature classification rating unless otherwise indicated or required by application.
- F. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
 - 1. Nominal Orifice: 1/2 inch, with discharge coefficient between 5.3 and 5.8.
- G. Sprinkler Finishes: Chrome plated.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
 - 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

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

2.5 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm Bell:
 - 1. Standard: UL 464.
 - 2. Type: Vibrating, metal alarm bell.
 - 3. Size: 6-inch minimum- 8-inch minimum- 10-inch diameter.
 - 4. Finish: Red-enamel factory finish, suitable for outdoor use.
 - 5. 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. Water-Flow Indicators:
 - 1. Standard: UL 346.
 - 2. Water-Flow Detector: Electrically supervised.
 - 3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 - 4. Type: Paddle operated.
 - 5. Pressure Rating: 250 psig.
 - 6. Design Installation: Horizontal or vertical.
- D. Pressure Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised water-flow switch with retard feature.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design Operation: Rising pressure signals water flow.
- E. Valve Supervisory Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design: Signals that controlled valve is in other than fully open position.
 - 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

2.6 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gage Range: 0- to 250-psig minimum.
- D. Label: Include WATER label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 SERVICE-ENTRANCE PIPING

- A. Reuse existing water-service piping for service entrance to building.
- B. Reuse the existing shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install Inspector's Test Connections in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- . Install alarm devices in piping systems.
- . Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

- L. Fill sprinkler system piping with water.
- M. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors.
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 OINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged oints: Select appropriate gasket material in size, type, and thickness suitable for water service. oin flanges with gasket and bolts according to ASME B31.9.
- G. Threaded oints: 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. oin pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked oints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs onequarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed oints: oin lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- . Welded oints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to Quality Assurance Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanizedsteel pipe.
- . Steel-Piping, Cut-Grooved oints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. oin steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved oints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. oin steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed oints: oin Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

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

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

3.6 SPRIN LER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wettype sprinklers in areas subject to freezing.
- C. Install sprinklers with stainless steel braided fully welded flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid. Flexible hose shall not use gaskets and shall be true 1" hose sizes.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, Systems Acceptance Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire department equipment. Provide letter to Architect with the approval of the thread type by the local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 DEMONSTRATION

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

3.11 PIPE HANGERS AND SUPPORTS

- A. This Contractor shall furnish and install all foundations and supports required for his equipment unless indicated otherwise on the Drawings.
- B. This Contractor shall furnish and install all escutcheons, inserts, thimbles, hangers, saddles, etc. required for the proper support and installation of his equipment and piping and he shall cooperate with other trades in locating and placing these items.

3.12 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Piping within the building 4 and smaller shall be Schedule 40 black steel pipe with threaded fittings. Piping larger than 4' shall be Schedule 40 black steel pipe with welded fittings. At Contractor's option, piping larger than 4 may be Schedule 10. At Contractor's option, roll grooved pipe with mechanical couplings may be used. Schedule 5 piping is <u>not</u> acceptable.

3.13 MECHANICAL GROOVED PIPING

- A. At the contractor's option, roll grooved piping and fittings may be used for the Fire Protection and HVAC piping systems inside building in lieu of connections hereinbefore specified. Cut grooved piping is not acceptable.
- B. Couplings shall be fabricated in two or more parts of malleable iron castings, in accordance Federal Specification QQ-I-666c, Grade II. Couplings gasket shall be molded synthetic rubber, per ASTM-D-75-61, Grade No. R615BZ. Coupling bolts shall be oval neck track head type with hexagonal heavy nuts, per ASTM A-183-60.
- C. All pipe fittings shall be fabricated of malleable iron castings in accordance with Federal Specifications QQ-1-666c, Grade II. Where malleable fitting pattern is not available, fittings fabricated from Schedule 40 steep pipe or standard wall seamless welded fittings with grooved ends may be used.

- D. Before assembly of couplings, light coat pipe ends and outside of gaskets with cup grease or graphite paste to facilitate installation.
- E. Pipe grooving shall be in accordance with the manufacturer's specifications contained in latest published literature.

3.14 VICTAULIC COUPLINGS

- A. At the contractor's option, Victaulic couplings and fittings may be used for the Fire Protection and HVAC piping systems inside building in lieu of connections hereinbefore specified.
- B. Couplings shall be manufactured in two or more parts of ASTM A-395 grade 65-45-15 and A-536 grade 65-45-12 ductile iron castings. Coupling gaskets shall be suited for the intended service as per manufacturer's guidelines and recommendations. Coupling bolts shall be zinc-plated carbon steel track head type with hexagonal heavy nuts, per ASTM A-183-60.
- C. Rigid Couplings shall be Victaulic Style 07, FireLock[™] Style 005, or equal with offsetting angle-pattern bolt pads, to provide rigidity and piping system support and hanging requirements in accordance with ANSI B31.1, B31.9, and NFPA 13.
- D. Flexible Couplings shall be Victaulic Style 75, or Victaulic Style 77, or equal: Flexible Couplings shall used in locations where stress relief and vibration attenuation are required. Couplings shall be placed in close proximity to the vibration source.
- E. Flange Adapters shall be Victaulic Style 741, or equal. Flange adapters shall be Class 150 flange adapters for grooved end pipe shall be manufactured in two or more parts of ASTM A-395 grade 65-45-15 and A-536 grade 65-45-12 ductile iron castings. Flange adapter gaskets shall be suited for the intended service as per manufacturer's guidelines and recommendations.
- F. All pipe fittings used with pipe couplings shall be fabricated of ductile iron conforming to ASTM A-395 grade 65-45-15 and A-536 grade 65-45-12 or forged carbon steel conforming to ASTM A234 grade WPB. Where Victaulic ductile iron or forged carbon steel fitting patterns are not available, fittings fabricated from schedule 40 steel pipe conforming to ASTM A-53 with grooved ends may be used. Fittings used in fire protection service shall be UL listed and FM approved, equal to Victaulic FireLockTM fittings.
- G. Pipe ends shall be clean and free from indentations, projections, and roll marks. Before assembly of couplings, lightly coat pipe ends and outside of gaskets with lubricant, cup grease or graphite paste to facilitate installation.
- H. Pipe grooving shall be in accordance with the manufacturer's specifications contained in latest published literature.
- I. All grooved couplings, fittings and flange adapters shall be the products of the same manufacturer. Grooving tools shall be of the same manufacturer as the grooved end components.

3.15 SPRIN LER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Concealed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Pendent, dry sprinklers.

- 5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Upright and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13



Section 22 00 00 – Plumbing General Provisions

PART 1 GENERAL

1.1 SUMMARY

A. The General Conditions of the Architectural Specifications, along with the supplementary conditions, special conditions, information to bidders, and any other pertinent information and documents shall apply the same as if repeated herein.

1.2 SCOPE OF WOR

- A. Furnish all labor and material necessary to provide and install the complete mechanical portion of this Contract, including plumbing systems as called for herein and on accompanying drawings. Parts of the mechanical division may be bid separately or in combination, at the Contractor's option; however, it shall be the responsibility of the General Contractor to assure himself that all items covered in the this Division have been included if he chooses to accept separate bids.
- B. This Contractor shall refer to the Architectural and Structural drawings and install equipment, piping, etc. to meet building and space requirements. No equipment shall be bid on or submitted for approval if it will not fit in the space provided.
- C. It is the intention of these Specifications that all mechanical systems shall be furnished complete with all necessary valves, controls, insulation, piping, devices, equipment, etc. necessary to provide a satisfactory installation in working order.
- D. Contractor shall visit the site and acquaint himself thoroughly with all existing facilities and conditions which would affect his portion of the work. Failure to do so shall not relieve the Contractor from the responsibility of installing his work to meet the conditions.

This Contractor shall protect the entire system and all parts thereof from injury throughout the project and up to acceptance of the work. Failure to do so shall be sufficient cause for the Architect to reject any piece of equipment.

1.3 DEMOLITION

- A. The contractor shall visit the site prior to bid to determine the extent of work required to complete the project.
- B. Contractor shall coordinate demolition with owner. The Owner shall have "First Right of Refusal" regarding salvage of all equipment and materials to be removed. Locate equipment as directed by owner. All equipment and materials not salvaged by the owner shall be removed from the site and discarded at the contractor's expense.
- C. Contractor shall coordinate all work with general contractor and phase work as required by project.
- D. All equipment piping, etc. required to be removed to accommodate the modifications shall be removed.

- E. Contractor shall maintain services to existing facilities which shall remain during and after construction is complete.
- F. Contractor shall coordinate any shutdown of services with the owner. It is intended that the building will remain occupied during construction. Contractor shall schedule shut down of services with the owner in order to prevent disruption of building occupancy.
- G. Contractor shall be responsible for draining down of existing systems to complete demolition. All work shall be scheduled with the owner. Contractor shall also be responsible for refilling system and removing all air in order to return the systems to proper operating conditions.
- H. All shut down of services shall be done at night or during a time period approved by the owner. The systems shall be required to be back up and running each morning unless otherwise approved by the owner.

1.4 GROUNDS AND CHASES

A. This Contractor shall see that all required chases, grounds, holes and accessories necessary for the installation of his work are properly built in as the work progresses; otherwise, he shall bear the cost of providing them.

1.5 CUTTING AND PATCHING

A. Initial cutting and patching shall be the responsibility of the General Contractor, with the Mechanical Contractor being responsible for laying out and marking any and all holes required for the reception of his work. No structural beams or joists shall be cut or thimbled without first receiving the approval of the Architect. After initial surfacing has been done, any further cutting, patching and painting shall be done at this Contractor's expense.

1.6 FILL AND CHARGES FOR EQUIPMENT

A. Fill and charge with materials or chemicals all those devices or equipment as required to comply with the manufacturer's guarantee or as required for proper operation of the equipment.

1.7 MACHINERY GUARDS

- A. This Contractor shall provide v-belt guards for each v-belt drive or other hazardous drive. The guard shall enclose the drive entirely and shall have a hole for taking a tachometer reading.
- B. Provide protective guard for belts, pulleys, gears, couplings, projecting set screws, keys and other rotating parts which are located such that a person might come in close proximity. Construct protective guard around angle iron frame, securely bolted to apparatus; comply with safety requirements. Install guard to completely enclose drives and pulleys and not interfere with lubrication of equipment. Provide 2 inch minimum diameter opening in fan belt guards housing for tachometer.

1.8 REPAIRING ROADWAYS AND WAL S

A. Where this Contractor cuts or breaks roadways or walks, in order to lay piping, he shall repair or replace these sections to meet the Architect's approval.

1.9 EXCAVATION AND BAC FILL

- A. Contractor shall perform all excavating necessary to lay the specified services. Perform excavation of every description and of whatever substance encountered to depths indicated or specified. Pile materials suitable for backfilling a sufficient distance from banks of trenches to prevent slides or caveins. Comply with OSHA requirements for excavation, trenching and shoring. Waste excavation materials, rubbish, etc. shall be carted away from the premises, as indicated. Remove water from trenches by pumping or other approved method, discharge at a safe distance from the excavation.
- B. Provide trenches of necessary width for proper laying of pipe and comply with latest publication of OSHA 2226 Excavating and Trenching Operations. Coordinate trench excavation with pipe installation to avoid open trenches for prolonged periods. Accurately grade bottoms of trenches to provide uniform bearing and support for each section of pipe on undisturbed soil or the required thickness of bedding material at every point along its entire length.
- C. Provide minimum 12 inches between outer surfaces and embankment or shoring, which may be used, when excavating for manholes and similar structures. Remove unstable soil that is incapable of supporting the structure in the bottom of the excavation to the depth necessary to obtain design bearing.
- D. Material to be excavated is "unclassified". No adjustment in the contract price will be made on account of the presence or absence of rock, shale, masonry, or other materials.
- E. Protect existing utility lines that are indicated or the locations of which are made known prior to excavating and trenching and that are to be retained. Protect utility lines encountered during excavating and trenching operations, from damage during excavating, trenching and backfilling; if damaged, repair lines as directed by utilities, owner and A/E. Issue notices when utility lines that are to be removed are encountered within the area of operations in ample time for the necessary measures to be taken to prevent interruption of the service.
- F. Provide trenches for utilities of a depth that will provide the following minimum depths of cover from existing grade or from indicated finished grades, or depths of cover in accordance with the manufacturer's recommendations, whichever is lower:
 - 1. 1-Foot Minimum Cover: Sanitary sewer, Oil/Water waste.
 - 2. 3-Feet Minimum Cover: Domestic water, fire line.
- G. Underground domestic water piping and fire line piping shall have a 6 bed of sand below the piping and backfilled with sand to 6 above the top of piping. Select fill may be used above the sand layer.
- H. Backfill trenches after piping, fittings and joints have been tested and approved. Backfill trenches with sand to provide 6 inches of sand below piping and 12 inches of sand cover above piping.
- I. Backfill remainder of trenches with satisfactory material consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones not over 1-1/2 inches in size. Deposit backfill material in 9 inch maximum layers, loose depth as indicated or as specified. Take care not to damage utility lines.
- . Deposit the remainder of backfill materials in the trench in 1 foot maximum layers and compact by mechanical means. Refer to architectural for minimum density for compaction (Minimum 85 percent of maximum soil density as determined by ASTM D 698). Re-open trenches and excavation pits improperly backfilled or where settlement occurs to the depth required to obtain the specified compaction, the refill and compact with the surface restored to the required grade and compaction.

Backfill utility line trench with backfill material, in 6 inch layers, where trenches cross streets, driveways, building slabs, or other pavement. Moisten each layer and compact to 95 percent of the maximum soil density as determined by ASTM D 698. Accomplish backfilling in such a manner as to permit the rolling and compaction of the filled trench with the adjoining material to provide the required bearing value so that paving of the area can proceed immediately after backfilling is complete.

1.10 NOISE AND VIBRATION

A. Provide the plumbing system and its associated components, items, piping, and equipment free of objectionable vibration or noise. Statically and dynamically balance rotating equipment and mount or fasten so that no vibration is transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions at no additional compensation.

1.11 PAINTING

- A. All painting shall be by the General Contractor's Painting Sub-Contractor. All pipe, pipe covering, equipment, supports, hangers, etc. exposed in the building or equipment room shall be painted. This Contractor shall prepare the surface of the material to receive the first coat of paint.
- B. All subsequent coatings shall be prepared by the Painting Sub-Contractor. Requirements covering paints, workmanship and preparation of surfaces as stated in the Architectural Specifications shall govern. Colors shall be approved by the Architect. All piping shall be color-coded.
- C. All piping shall be color coded per the following:
 - 1. Natural Gas Piping (Exposed in Mechanical Room)
 - 2. Natural Gas Piping (Outdoor, Roof, Exterior of Building)
 - 3. Natural Gas Piping (Exposed in Building)
 - 4. Sanitary Sewer Waste Vent (Exposed in Building)
 - a. Thermoplastic pipe and fittings shall be painted using latex(water base) paint .
 - b. Pipe should be cleaning to remove moisture, dirt and oil; then wiped with a clean, dry cloth.
 - c. Do not use petroleum based paints.

1.12 CLEANING AND AD USTING

A. Upon completion of his work, the Contractor shall clean and adjust all equipment, controls, valves, etc.; clean all piping, ductwork, etc.; and leave the entire installation in good working order.

1.13 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Provide the Owner with three (3) copies of printed instructions indicating various pieces of equipment by name and model number, complete with parts lists, maintenance and repair instructions and test and balance report.
- B. COPIES OF SHOP DRAWINGS WILL NOT BE ACCEPTABLE AS OPERATION AND MAINTENANCE INSTRUCTIONS BUT MUST BE INCLUDED IN SUBMITTAL PAC AGE.
- C. This information shall be bound in plastic hardbound notebooks with the job name permanently embossed on the cover. Rigid board dividers with labeled tabs shall be provided for different pieces of equipment. Submit manuals to the Architect for approval.

Yellow

Yellow

Black

Black

- D. In addition to the operation and maintenance brochure, the Contractor shall provide a separate brochure which shall include registered warranty certificates on all equipment, especially any pieces of equipment which carry warranties exceeding one (1) year.
- E. The operation and maintenance brochure shall be furnished with a detailed list of <u>all</u> equipment furnished to the project, including the serial number and all pertinent nameplate data such as voltage, amperage draw, recommended fuse size, rpm, etc. The Contractor shall include this data on <u>each</u> piece of equipment furnished under this contract.

1.14 GUARANTEE

A. The Contractor shall guarantee all materials, equipment and workmanship for a period of one (1) year from the date of final acceptance of the project. This guarantee shall include furnishing of all labor and material necessary to make any repairs, adjustments or replacement of any equipment, parts, etc. necessary to restore the project to first class condition. This guarantee shall exclude only the changing or cleaning of filters. Warranties exceeding one (1) year are hereinafter specified with individual pieces of equipment.

1.15 LOCAL CONDITIONS

- A. The location and elevation of all utility services is based on available surveys and utility maps and are reasonably accurate; however, these shall serve as a general guide only, and the Contractor shall visit the site and verify the location and elevation of all services to his satisfaction in order to determine the amount of work required for the execution of the Contract.
- B. The Contractor shall contact the various utility companies, determine the extent of their requirements and he shall include in his bid all lawful fees and payments required by these companies for complete connection and services to the building, including meters, connection charges, street patching, extensions from meters to main, etc.
- C. In case major changes are required, this fact, together with the reasons therefor, shall be submitted to the Architect, in writing, not less than seven (7) days before the date of bidding. Failure to comply with this requirement will make the Contractor liable for any changes, additions and expenses necessary for the successful completion of the project.

1.16 PERMITS, INSPECTIONS AND TESTS

- A. All permits, fees, etc. for the installation, inspections, plan review, service connections locations, and/or construction of the work which are required by any authority and/or agencies having jurisdiction, shall be obtained and paid for by the Contractor. This shall be verified during the bidding process.
- B. The Contractor shall make all tests required by the Architect, Engineer or other governing authorities at no additional cost to the Owner.
- C. The Contractor shall notify the Architect and local governing authorities before any tests are made, and the tests are not to be drawn off a line covered or insulated until examined and approved by the authorities. In event defects are found, these shall be corrected and the work shall be retested.

- D. Prior to requesting final inspection by the Architect, the Contractor shall have a complete coordination and adjustment meeting of all of his sub-contractors directly responsible for the operation of any portion of the system. At the time of this meeting, each and every sequence of operation shall be checked to assure proper operation. Notify the Architect in writing ten (10) days prior to this meeting, instructing him of the time, date and whom you are requesting to be present.
- E. This project shall not be accepted until the above provisions are met to the satisfaction of the Architect.

1.17 CODES AND STANDARDS

- A. The entire mechanical work shall comply with the rules and regulations of the City, Parish, County and the State in which this project is being constructed, including the State Fire Marshal and the State Department of Health. Modifications required by these authorities shall be made without additional charge to the Owners. The Contractor shall report these modifications to the Architect and secure his approval before work is started.
- B. In addition to the codes heretofore mentioned, mechanical work and equipment shall conform to the applicable portions of the following specifications, codes and/or regulations:
 - 1. American Society of Heating, Refrigeration and
 - 2. Air Conditioning Engineers (ASHRAE)
 - 3. National Electrical Code (NEC)
 - 4. National Fire Protection Association (NFPA)
 - 5. American Society of Mechanical Engineers (ASME)
 - 6. American Gas Association (AGA)
 - 7. International Building Code (IBC)
 - 8. International Mechanical Code (IMC)
 - 9. International Plumbing Code (IPC)
 - 10. International Fuel Gas Code (IFGC)
 - 11. Underwriters Laboratories (UL)
 - 12. Life Safety Code (NFPA 101)
 - 13. State Sanitary Code
 - 14. Louisiana State Uniform Construction Code Council (LSUCCC)
 - C. Materials, equipment and accessories installed under this Contract shall conform to the rules, codes, etc. as recommended by National Associations governing the manufacturer, rating and testing of such materials, equipment and accessories. Materials shall be new and of the best quality and first class in every respect. Whenever directed by the Architect, the Contractor shall submit a sample for approval before proceeding.
 - D. Where laws or local regulations provide that certain accessories such as gauges, thermometers, relief valves and parts be installed on equipment, it shall be understood that such equipment be furnished complete with the necessary accessories, whether or not called for in these Specifications.
 - E. Unfired pressure vessels shall be built in accordance with the A.S.M.E. Code and so stamped. Furnish shop certificates for each vessel.

1.18 REVIEW OF MATERIALS

- A. Whenever manufacturers or trade names are mentioned in these Plans or Specifications, the words or approved equivalent shall be assumed to follow whether or not so stated. Manufacturers or trade names are used to establish a standard of quality only, and should not be construed to infer a preference. Equivalent products which meet the Architect's approval will be accepted; however, these products must be submitted to the Architect a minimum of seven (7) days prior to the Bid Date.
- B. Submission shall include the manufacturer's name, model number, rating table and construction features.
- C. Upon receipt and checking of this submittal, the Architect will issue an addendum listing items which are approved as equivalent to those specified. THE CONTRACTOR SHALL BASE HIS BID SOLELY ON THOSE ITEMS SPECIFIED OR INCLUDED IN THE PRIOR APPROVAL ADDENDUM, AS NO OTHER ITEM WILL BE ACCEPTABLE.
- D. Prior approval of a particular piece of equipment does not mean automatic final acceptance and will not relieve the Contractor of the responsibility of assuring himself that this equipment is in complete accord with the Plans and Specifications and that it will fit into the space provided. Shop drawings must be submitted on all items of equipment for approval as hereinafter specified.
- E. Before proceeding with work and/or within thirty (30) days after the award of the General Contract for this work, the Mechanical Contractor shall furnish to the Architect complete shop and working drawings of such apparatus, equipment, controls, insulation, etc. to be provided in this project. These drawings shall give dimensions, weights, mounting data, performance curves and other pertinent information.
- F. The Architect's approval of shop drawings shall not relieve the Contractor from the responsibility of incorrectly figured dimensions or any other errors which may be contained in these drawings. Any omission from the shop drawings or specifications, even though approved by the Architect, shall not relieve the Contractor from furnishing and erecting same.
- G. Six (6) sets of shop drawings shall be submitted to the Architect for approval. These submittals shall be supplied as part of this Contractor's contract. Any drawings not approved shall be resubmitted until they are approved.
- H. This information shall be bound in plastic hardbound notebooks with the job name permanently embossed on the cover. Rigid board dividers with labeled tabs shall be provided for different pieces of materials and equipment. Submit shop drawings to the Architect for approval. Faxed copies submissions will not be accepted.

1.19 MINOR DEVIATIONS

A. Plans and detail sketches are submitted to limit, explain and define conditions, specified requirements, pipe sizes and manner of erecting work. Structural or other conditions may require certain modifications from the manner of installation shown, and such deviations are permissible and shall be made as required. However, specified sizes and requirements necessary for satisfactory operation shall remain unchanged. It may be necessary to shift ducts or pipes, or to change the shape of ducts, and these changes shall be made as required. All such changes shall be referred to the Architect and Engineer for approval before proceeding. Extra charges shall not be allowed for these changes. The contractor shall obtain a full set of plans and specifications for the coordination of his work prior to bidding this project. Items which are unclear to the bidding contractor shall be brought to the Architect

and Engineers attention prior to bidding the project. An interpretation shall be clarified by the Architect and/or the Engineer prior to bidding.

- B. The Contractor shall realize that the drawings could delve into every step, sequence or operation necessary for the completion of the project, without drawing on the Contractor's experience or ingenuity. However, only typical details are shown on the Plans. In cases where the Contractor is not certain about the method of installation of his work, he shall ask for details. Lack of details will not be an excuse for improper installation.
- C. In general, the drawings are diagrammatic and the Contractor shall install his work in a manner so that interferences between the various trades are avoided. In cases where interferences do occur, the Architect is to state which item was first installed.

1.20 AS-BUILT RECORD DRAWINGS

- A. The Contractor shall obtain at his cost, two sets of blue line prints of the original bid documents by the Architect. One set shall be kept on the site with all information as referenced below, and shall update same as the work progresses. The other set will be utilized to record all field changes to a permanent record copy for the Owner.
- B. If the Contractor elects to vary from the Contract Documents and secures prior approval from the Architect for any phase of the work, he shall record in a neat and readable manner, <u>ALL</u> such variances on the blackline print in red. The original blackline prints shall be returned to the Architect for documentation.
- C. All deviations from sizes, locations, and from all other features of the installations shown in the Contract Documents shall be recorded.
- D. In addition, it shall be possible using these drawings to correctly and easily locate, identify and establish sizes of all piping, directions and the like, as well as other features of the work which will be concealed underground and/or in the finished building.
- E. Locations of underground work shall be established by dimensions to columns, lines or walls, locating all turns, etc., and by properly referenced centerline or invert elevations and rates of fall.
- F. For work concealed in the building, sufficient information shall be given so it can be located with reasonable accuracy and ease. In some cases this may be by dimension. In others, it may be sufficient to illustrate the work on the drawings in relation to the spaces in the building near which it was actually installed. The Architect's/Engineer's decision in this matter will be final.
- G. The following requirements apply to all As-Built drawings:
 - 1. They shall be maintained at the Contractor's expense.
 - 2. All such drawings shall be done carefully and neatly, and in a form approved by the Architect/Engineer.
 - 3. Additional drawings shall be provided as necessary for clarifications.
 - 4. These drawings shall be kept up-to-date during the entire course of the work and shall be available upon request for examination by the Architect/Engineer; and when necessary, to establish clearances for other parts of the work.
 - 5. "As-built" drawings shall be returned to the Architect upon completion of the work and are subject to approval of the Architect/Engineer.

1.21 REQUIRED SHOP DRAWING SUBMITTALS

- A. Provide the following shop drawing submittals:
 - 1. Pipe insulation.
 - 2. All Valves.
 - 3. Plumbing fixtures and trim.
 - 4. Pipe and pipe fittings.
 - 5. PVC jacket color samples.
 - 6. Water Heaters.
 - 7. Mixing Valves.
 - 8. Pumps.
 - 9. Oil and Water Separators.

PART 2 PRODUCTS

2.1 PLUMBING PRODUCTS

A. Refer to individual Division 22 sections for plumbing products, pipe, tube and fitting materials and joining methods.

PART 3 EXECUTION

3.1 MANUFACTURER'S DIRECTION

- A. The contractor shall install and operate equipment and material in accordance with the manufacturer's installation and operating instructions. The manufacturer's instructions of installation and operation shall become part of the Contract Documents and shall supplement the Drawings and Specifications.
- B. Store equipment in a clean, dry place protected from other construction. While stored, maintain factory wrapping or tightly cover and protect equipment against dirt, water, construction debris, chemical, physical or weather damage, traffic and theft.

3.2 EQUIPMENT LABELS

A. Provide equipment labels for water heaters and mixing valves. Labels shall have permanent laminated construction secured to equipment.

3.3 PIPE LABELS

A. Provide pipe markers and directional arrows on all piping in mechanical equipment rooms, or which is exposed in building, and on both sides of all valves located above ceiling. Markers shall be as manufactured by W.H. Bradley Co., Marking Services Inc. or the equivalent. All letters shall be color-coded and sized as recommended by OSHA. Samples of the type of letters to be used shall be submitted with shop drawings. Piping shall be color-coded.

- B. Pipe markers with arrows shall indicate lines content and shall be located 20 feet on center and at each change of direction of line. Identification bands shall be color coded to match pipe markers and shall be provided 10 feet on center. Pipe identification markers shall be taped at each end and shall be taped around the entire circumference of pipe.
- C. The following Piping shall be identified:
 - 1. Domestic Cold Water
 - 2. Domestic Hot Water
 - 3. Domestic Hot Water Return
 - 4. Natural Gas
 - 5. Sanitary Sewer
 - 6. Sanitary Vent
 - 7. Vapor Vent
 - 8. Condensate Drain

3.4 ACCESS DOORS:

- A. Provide access doors in walls, floors and ceilings to permit access to equipment and piping requiring service or adjustment.
 - 1. Valves.
 - 2. Plumbing drainage cleanouts.
 - 3. Other Plumbing equipment indicated in schedules or specifications which are requiring maintenance, adjustment or operation.
- B. Provide hinged access doors and frames as follows:
 - 1. Drywall Construction:
 - a. Provide with concealed spring hinges and flush screwdriver operated cam locks in sufficient number of the size of the panel.
 - b. Provide prime paintable surface (not galvanized).
 - c. Product: Milcor "Style M" (Karp DSC-214M).
 - 2. Visible Masonry and Ceramic Tile:
 - a. Milcor "Style M" (Karp DSC-214M).
 - 3. Cement Plaster:
 - a. Milcor "Style K" (KarpDSC-214 PL).
 - 4. Acoustical Plaster:
 - a. Reinforced panel as required to prevent sagging. Provide continuous steel piano type hinge for the length of the panel, and sufficient number for the size of the panel. Provide factory prime paint surface (not galvanized).
 - b. Product: Milcor "Style AP" (Karp 214 PL).
 - 5. Acoustical Tile:
 - a. Milcor "Style AT" (Larsen L-CPA).
- C. Provide continuous concealed hinges and cam locks.

- D. Provide UL listed 1-1/2 hour label "B" access doors with automatic self-closing latching mechanism where required.
- E. Provide removable ceiling access tile section immediately adjacent to each mechanical or electrical device located in the ceiling plenum above removable tile ceiling.
- F. Coordinate approval of type, color and location of access doors frames with Architect.

3.5 CLEANING AND SERVICE

- A. Upon Completion of this work, the contractor shall clean and adjust equipment, controls, valves, etc.;
- B. Clean piping, fixtures, cleanout covers, floor drain covers, etc. and leave the entire installation in good working order.
- C. Adjust flush valves and faucets to allow for proper operation.

END OF SECTION 22 00 00

Section 22 05 23 - General Duty Valves for Plumbing

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes the furnishing and installation of general duty valves for plumbing:

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.
1. Certification that products comply with NSF 61 Annex G and NSF 372 (lead free).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections.

- 6. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
 - 2. Hand lever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 MANUFACTURERS

- A. Valves shall be manufactured by one of the following:
 - 1. itz.
 - 2. Red White.
 - 3. Nibco.
 - 4. ennedy.
 - 5. Crane.
 - 6. Milwaukee.
 - 7. eystone.
 - 8. Stockham.
 - 9. Grinnell.
 - 10. Mueller.
 - 11. amesbury.
 - 12. DeZurik.
 - 13. Hammond.
 - 14. Apollo.

2.3 BRONZE BALL VALVES

- A. Two-Piece, Bronze Ball Valves with Full Port and Brass Trim:
 - itz 59/69, Apollo 77C, NIBCO Design S-580-70, Milwaukee BA-150-S, Red White 5049F or equal, threaded ends of heating hot water and low pressure steam of itz 58/68, Apollo 77CLF, NIBCO Design T-580-70, Milwaukee BA-100-S, Red White 5044F or equal. For insulated piping systems, provide ball valves with extended stem, insulated handle with protective thermal barrier sleeve to prevent condensate moisture drip and pipe insulation deterioration.
 - 2.
 - 3. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. SSP Rating: 150 psi.

- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded and soldered.
- g. Seats: PTFE.
- h. Stem: Brass. Blow-out proof.
- i. Ball: Chrome-plated brass.
- j. Port: Full.
- k. Vinyl covered steel handle.
- l. Lead Free.
- m. Conforms to ASTM B-62.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Unions are not required on flanged devices.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags.
- F. All valves, unions, etc. where pipe is chrome plated shall have similar finish. All exposed supplies to plumbing fixtures shall be chrome plated.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. All gas cocks, valves, etc. on gas lines shall have local utility company and AGA approval.

- C. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Solder ends, except provide threaded ends for heating hot water.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends or grooved ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Grooved end or Flanged ends except where threaded valveend option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Grooved end or Flanged ends.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller (above grade):
 - 1. Two-piece, bronze ball valves with full port and brass trim.
- B. Domestic water valves (below grade):
 - 1. M H AWWA Series C-509, NIBCO T113 (3/4 to 2), NIBCO T619 (2-1/2 and above) resilient gate valve with low torque operation, positive shut-off, O- Ring seals, full epoxy coating and square valve stem end.
 - 2. Provide two (2) adjustable TEE handle valve wrenches to be turned over to the owner after construction is complete.

END OF SECTION 22 05 23

Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

- 1. Trapeze pipe hangers.
- 2. Metal framing systems.
- 3. Pipe stands.
- 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. <u>Manufacturers:</u> 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. <u>B-line, an Eaton business</u>.
 - b. <u>Flex-Strut Inc</u>.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with inturned lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 7. Metallic Coating: Electroplated zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. <u>Manufacturers:</u> 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. <u>Buckaroos, Inc</u>.
 - 2. <u>Carpenter Paterson, Inc</u>.
 - 3. <u>Clement Support Services</u>.
 - 4. <u>National Pipe Hanger Corporation</u>.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pullout, tension, and shear capacities appropriate for supported loads and building materials where used. B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece **plastic** stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic Stainless steel .
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

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

2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

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

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 Roof Accessories for curbs.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- . Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

3.2 EQUIPMENT SUPPORTS

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

3.3 METAL FABRICATIONS

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

3.4 AD USTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 Exterior Painting. Section 099123 Interior Painting. Section 099600 High-Performance Coatings.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- . Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

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

- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 - 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 - 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 - 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 - 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

Section 22 07 19 - Plumbing Piping Insulation

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Sanitary drain piping receiving condensate.
 - 4. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

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

1.4 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.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Reject damaged, deteriorated, wet, or contaminated material and immediately remove from the site. Replace removed materials at no additional cost to Owner.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Insulation:
 - 1. Pittsburgh-Corning.
 - 2. Owens- Corning.
 - 3. Certainteed.
 - 4. Armacell.
 - 5. Rubatex.
 - 6. nauf.
 - 7. ohns Manville.

B. acketing:

- 1. Ceel-Co.
- 2. O'Brien.
- 3. Zeston.
- 4. Childers.
- 5. Pabco.

C. Adhesives:

- 1. Benjamin Foster.
- 2. Childers.
- 3. Vimasco.
- 4. B.E.H.

2.2 INSULATION MATERIALS

- A. Comply with requirements in Piping Insulation Schedule, General, Indoor Piping Insulation Schedule, Outdoor, Aboveground Piping Insulation Schedule, and Outdoor, Underground Piping Insulation Schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Density of 5.0 lbs/cubic foot.
 - 2. factor of 0.27 at 75 degrees F mean.
 - 3. Maximum water vapor transmission of 0.17 per inch.
 - 4. Must be listed for 25/50 flame/smoke spread of thickness used.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in Factory-Applied ackets Article.
- H. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied AS -SSL. Factory-applied jacket requirements are specified in Factory-Applied ackets Article.
 - 1. All-service jacket AS -SSL type factory applied jacketing.
 - 2. 6 lbs/cu ft minimum density.
 - 3. k-factor of 0.31 maximum at 200 degrees F mean.
 - 4. 850 degree F service temperature.
 - 5. 0.02 perm maximum acket permeance.

2.3 PIPE AND FITTING COVERS

- A. Polyvinyl Chloride (PVC) Covers:
 - 1. Ultraviolet resistant.
 - 2. 0.020 inch minimum thickness.
 - 3. Preformed to match outer diameter of insulation.
 - 4. Preformed fitting covers, minimum 10 mil.
- B. Aluminum (A) Covers:
 - 1. ASTM B209, Alloy 3003 minimum.
 - 2. 0.016-inch thickness.
 - 3. Bright anodized or acrylic-coated smooth finish on exposed side.
 - 4. 2-piece tee and ribless elbow covers in minimum 0.016-inch, preformed.
 - 5. Provide moisture barrier backing and butt-joint with mastic seal for joining of adjacent sections.

2.4 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. AS Adhesive, and FS acket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC acket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

- A. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 2. Service Temperature Range: 0 to 180 deg F.
 - 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 4. Color: White.

2.6 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: 0 to plus 180 deg F.
 - 4. Color: White.

2.7 SEALANTS

- A. oint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.
- B. AS Flashing Sealants, and Vinyl, PVDC, and PVC acket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

2.8 FACTORY-APPLIED AC ETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factoryapplied jackets are indicated, comply with the following:
 - 1. AS -SSL: AS with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.9 TAPES

- A. AS Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. AS Tape Disks and Squares: Precut disks or squares of AS tape.

2.10 SECUREMENTS

- A. Bands:
 - 1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy.

2.11 PROTECTIVE SHIELDING GUARDS

- 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. eep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- . Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
 - Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.

- 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 Penetration Firestopping for firestopping and fireresistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 Penetration Firestopping.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word union. Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on

each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

- 3. Construct removable valve insulation covers in same manner as for flanges, except divide the twopart section on the vertical center line of valve body.
- 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
- 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

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

- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED AC ET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factoryapplied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FS jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vaporbarrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

- A. Insulation with AS, Glass-Cloth, or Other Paintable acket Material: Paint jacket with paint system identified below and as specified in Section 099113 Exterior Painting and Section 099123 Interior Painting.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

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

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- B. Domestic Hot and Recirculated Hot Water Mains:
 - 1. NPS 2 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 2. NPS 2-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
- C. Domestic Hot Water Supply and Return runouts (up to NPS 2 and not exceeding 12 feet in length from fixture shutoff valve back toward main line):
 - 1. NPS 2 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- D. Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities (Handicapped Lavatory Sinks P-Trap Supply Lines):
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Insulate p-trap, tailpiece and water supplies on handicapped lavatories with white, Truebro Model 102, Zurn 8947 handi lav-guard, or approved equivalent insulating system to meet A.D.A. Requirements. Provide accessories for offset tailpiece as required.

- E. Floor Drains, Traps, and aboveground Sanitary Drain Piping receiving HVAC condensate:
 - All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Mineral-Fiber, ¾ lb density, ductwrap insulation with aluminum foil vapor barrier, Type I: 2 inch thick.
- F. Exposed Domestic Cold and Hot Water Piping.
 - 1. All exposed domestic cold and hot water piping shall also have field install PVC jacket.
- G. Sewer Waste and Vent Piping:

1.

1. Where Contractor elects to use schedule 40 PVC waste and vent piping (in lieu of cast iron piping) (exposed, in furrings, or above ceilings) (vertical and horizontal lines) shall be insulated with 2 thick 3/4 # density fiberglass ductwrap insulation with aluminum foil vapor barrier. Insulation shall be sealed at all seams and joints. Insulation shall be installed with a foil backed adhesive tape around the diameter of the pipe with insulation at 24 on center intervals.

3.12 INDOOR, PIPING WITHIN CMU BLOC WALLS PIPING INSULATION SCHEDULE

A. Domestic cold water, hot water and condensate drain lines shall be insulated with 1/2 thick flexible closed cell elastomeric thermal tube insulation as manufactured by Armaflex AP, Rubatex or prior approved equal. All joints are to be firmly butted together. All lap and butt joint strips are to be sealed in place with vapor barrier adhesive. Fittings are to be mitered segments of insulation held in place with vapor barrier sealant. Engineered Polymer Foam Insulation (EPFI) will not be accepted.

3.13 INDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Domestic cold and hot water lines run below slab within building shall be insulated with 1/2 thick flexible closed cell elastomeric thermal tube insulation as manufactured by Armaflex AP, Rubatex or prior approved equal.
- B. All joints are to be firmly butted together. All lap and butt joint strips are to be sealed in place with vapor barrier adhesive. Fittings are to be mitered segments of insulation held in place with vapor barrier sealant.
- C. Engineered Polymer Foam Insulation (EPFI) will not be accepted.
- D. Apply two (2) coats of mastic on insulation.

3.14 OUTDOOR, ABOVE GROUND PIPING INSULATION SCHEDULE

- A. All water lines on the outside of the building exposed to the weather shall be insulated with 1/2 thick flexible closed cell elastomeric thermal tube insulation as manufactured by Armaflex AP, Rubatex or prior approved equal.
- B. All joints are to be firmly butted together. All lap and butt joint strips are to be sealed in place with vapor barrier adhesive. Fittings are to be mitered segments of insulation held in place with vapor barrier sealant.
- C. Engineered Polymer Foam Insulation (EPFI) will not be accepted.
- D. Apply two (2) coats of mastic on insulation.

E. Lines shall be covered with 0.016 smooth aluminum jacket and elbows. At contractor's option, in lieu of 0.016 aluminum jacket, the contractor may use Venture Clad 1577CW multi-layered laminate coated, acrylic pressure sensitive adhesive jacket system.

3.15 UNDERGROUND, FIELD-INSTALLED INSULATION AC ET

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

END OF SECTION 22 07 19

Section 22 11 16 - Domestic Water Piping

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
 - 2. Encasement for piping.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- C. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Lead free Solder-joint.

2.3 PIPING OINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 150 psig.
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTHWOR

A. Comply with requirements in Section 220000 Plumbing General Provisions for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's Copper Tube Handbook.
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install domestic water piping level and plumb.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. 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.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.

- . Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- . Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors.
- N. Install sleeve seals for piping penetrations of concrete walls and slabs.
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- P. Domestic cold water lines penetrating concrete slabs shall be wrapped with "Protect-O-Sleeve" vinyl flexible tube as manufactured by Robert H. Harris Co., ones Stephen or equivalent.

3.3 OINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Brazed oints for Copper Tubing: Comply with CDA's Copper Tube Handbook, Brazed oints chapter.
- D. Soldered oints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. oin copper tube and fittings according to ASTM B 828 or CDA's Copper Tube Handbook.

3.4 TRANSITION FITTING INSTALLATION

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

3.5 HANGER AND SUPPORT INSTALLATION

A. Provide pipe hangers and support products. Install as per the following:

DOMESTIC WATER PIPING

- 1. Vertical Piping: MSS Type 8 or 42, clamps.
- 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
- 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

- 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
- 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

A. Identify system components.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in Piping Tests Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.

- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 AD USTING

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

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of available chlorine. Isolate with valves and allow to stand for 24 hours (minimum time shall be 6 hours). A chlorine residual of at least 5 ppm should remain before the lines are put in use.
 - 3. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - a. Repeat procedures if biological examination shows contamination.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction.

- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Underground piping up to 5'-0" from building, domestic cold water, building-service piping, NPS 4 and smaller, shall be the following:
 - 1. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
- E. Aboveground domestic water piping, NPS 4 and smaller, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L; copper, solder-joint fittings; and soldered joints.

3.12 VALVE SCHEDULE

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

END OF SECTION 22 11 16

Section 22 11 19 - Domestic Water Piping Specialties

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Water-hammer arresters.
 - 3. Escutcheons
 - 4. Trap-seal primer valves.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 1.4 INFORMATIONAL SUBMITTALS
 - A. Field quality-control reports.
- 1.5 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

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

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREA ERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Standard: ASSE 1001.
 - 2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 3. Body: Bronze.
 - 4. Inlet and Outlet Connections: Threaded.
 - 5. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers:
 - 1. Standard: ASSE 1011.
 - 2. Body: Bronze, non-removable, with manual drain.
 - 3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 4. Finish: Chrome or nickel plated.

2.4 WATER-HAMMER ARRESTERS

- A. Water-Hammer Arresters:
 - 1. <u>Manufacturers:</u> 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. <u>AMTROL, Inc</u>.
 - b. <u>Precision Plumbing Products</u>.
 - c. <u>Sioux Chief Manufacturing Company, Inc</u>.
 - 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Copper tube with piston.
 - 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.
 - 5. Plumbing fixtures with quick closing valves (i.e.: Dishwashers, Ice Maker, Tub/Shower Valve, Washing Machines, etc.) install Shock Trol, Precision Plumbing Products, Sioux Chief "Hydra-Rester", or equal water Hammer arrester properly sized for each unit.

2.5 ESCUTCHEONS

A. Provide escutcheons for all exposed lines passing through floors, walls, and ceilings. They shall be chrome plated brass and shall be of such flange size as to cover necessary penetrating openings.

2.6 TRAP-SEAL PRIMER DEVICE

- A. Supply-Type, Trap-Seal Primer Device:
 - 1. Standard: ASSE 1018.
 - 2. Pressure Rating: 125 psig minimum.
 - 3. Body: Bronze.
 - 4. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
 - 5. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
 - 6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
- B. Drainage-Type, Trap-Seal Primer Device:
 - 1. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
 - 2. Size: NPS 1-1/4 minimum.
 - 3. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install water-hammer arresters in water piping according to PDI-WH 201.
- B. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- C. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

END OF SECTION 22 11 19

Section 22 12 19-Natural Gas Distribution and Piping

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SERVICE

- A. Contractor shall contact local utility company, determine the extent of their requirements and include in his price all costs required for the complete installation of gas service, meter and regulator.
- B. Contractor shall include routing gas main from local utility main to the building and throughout project as indicated on Drawings.
- C. Contractor shall provide gas pressure regulator downstream of the meter to provide adequate gas pressure to equipment furnished in project. Coordinate gas supply pressure and equipment supply pressure requirements with utility company and equipment manufacturers.

1.3 SUMMARY

- A. Section Includes:
 - 1. Natural gas pipes, tubes, and fittings in the buildings.
- B. Product Data: For piping, transition fittings and dielectric fittings.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

3.2 HANGER AND SUPPORT INSTALLATION

- A. Provide pipe hangers and support products. Install as per the following:
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

3.3 IDENTIFICATION

- A. Identify system components.
- B. All piping below grade shall be installed with a 14 Gauge tracer wire on complete system below grade. Tracer wire shall stub up at each pipe penetration from below grade and be secured to the pipe.

3.4 FIELD QUALITY CONTROL

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

- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- 2. Piping Tests:
 - a. All low pressure gas piping shall be tested with a 10 mercury column for thirty (30) minutes.
 - b. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - c. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - d. Prepare reports for tests and for corrective action required.
- B. Natural gas water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Natural gas piping, NPS 4 and smaller, shall be the following:
 - 1. Gas piping on the building interior of the building shall be standard black steel, Schedule 40, National Tube Co., or equal. Fittings which are 2 inches and below shall be malleable screw fittings. Piping above 2 inches shall be electrically welded utilizing weld fittings.
 - 2. Gas piping on the exterior of the building and on the roof shall be the same as specified above, except to be coated with Scotch- ote polyethylene coating (20 mil) and all joints weatherproofed with two coats of field applied Scotch- ote wrapping tape.
 - 3. Gas piping below grade shall be orange polyethylene pipe ASTM D-3350, PE 23533E with polyethylene butt fusion weld fittings.

END OF SECTION 22 12 19

Section 22 13 16 - Sanitary Waste And Vent Piping

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. PVC pipe and fittings.
 - 2. Encasement for underground metal piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Design Submittals:
 - 1. <u>Product Data</u>: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

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

- 1. Notify Architect no fewer than two days in advance of proposed interruption of sanitary waste service.
- 2. Do not proceed with interruption of sanitary waste service without Architect's written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

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

2.3 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, Plastics Piping Systems Components and Related Materials, for plastic piping components. Include marking with NSF-dwv for plastic drain, waste, and vent piping and NSFsewer for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40 will not be accepted.
- D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns.
- E. PVC Pressure Fittings: ASTM D 2466, Socket Type
- F. Primer: ASTM F 656.
 - 1. Primer shall have a VOC content of 550g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24)
 - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers"
- G. Solvent Cement: ASTM D 2564.

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

2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 2. Unshielded, Nonpressure Transition Couplings:
 - a. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1) <u>Dallas Specialty Mfg. Co</u>.
 - 2) <u>Fernco Inc</u>.
 - 3) <u>Mission Rubber Company, LLC; a division of MCP Industries</u>.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 3. Shielded, Nonpressure Transition Couplings:
 - a. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1) <u>Cascade Waterworks Mfg. Co</u>.
 - 2) <u>Mission Rubber Company, LLC; a division of MCP Industries</u>.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - 4. Pressure Transition Couplings:
 - a. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1) <u>Apollo Valves; a part of Aalberts Integrated Piping Systems</u>.
 - 2) <u>EBAA Iron Sales, Inc</u>.
 - 3) <u>Romac Industries, Inc</u>.

- b. Standard: AWWA C219.
- c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
- d. Center-Sleeve Material: Manufacturer's standard.
- e. Gasket Material: Natural or synthetic rubber.
- f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
 - 1. Dielectric Unions:
 - a. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1) <u>A.Y. McDonald Mfg. Co</u>.
 - 2) <u>WATTS; A Watts Water Technologies Company</u>.
 - 3) <u>Wilkins</u>.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
 - 2. Dielectric Flanges:
 - a. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1) <u>Capitol Manufacturing Company</u>.
 - 2) <u>WATTS; A Watts Water Technologies Company</u>.
 - 3) <u>Zurn Industries, LLC</u>.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solderjoint copper alloy and threaded ferrous.
 - 3. Dielectric-Flange Insulating its:
 - a. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1) <u>Advance Products Systems, LLC</u>.
 - 2) <u>CALPICO, Inc</u>.
 - 3) <u>GF Piping Systems: Georg Fischer LLC</u>.
 - 4) <u>GPT; a division of EnPRO Industries</u>.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.

- 3) Gasket: Neoprene or phenolic.
- 4) Bolt Sleeves: Phenolic or polyethylene.
- 5) Washers: Phenolic with steel backing washers.
- 4. Dielectric Nipples:
 - a. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - 2) <u>Precision Plumbing Products</u>.
 - 3) <u>Victaulic Company</u>.
 - b. Description:
 - 1) Standard: IAPMO PS 66.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film manufactured of virgin polyethylene material conforming to the requirements of ASTM D 1248, and a minimum thickness of 0.008-inch thicknessor, high-density, cross-laminated polyethylene film manufactured of virgin polyethylene material conforming to the requirements of ASTM D 1248, and a minimum thickness of 0.004-inch.
- C. Form: Sheet or, Tube
- D. Color: Black or, Natural
- E. Install polyethylene encasement for Hubless, Service, and Extra Heavy DWV cast iron pipe and fitting systems in accordance with ASTM A74, X3, and CISPI Handbook.

PART 3 - EXECUTION

3.1 EARTH MOVING

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

3.2 PIPING INSTALLATION

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

- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- . Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- . Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install steel piping according to applicable plumbing code.
- N. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's Copper Tube Handbook.
- P. Install aboveground PVC piping according to ASTM D 2665.
- Q. Install underground PVC piping according to ASTM D 2321.
- R. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- S. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- T. Install underground, copper, force-main tubing according to CDA's Copper Tube Handbook.
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- U. Install force mains at elevations indicated.
- V. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 Sanitary Waste Piping Specialties.
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 Sanitary Waste Piping Specialties.
 - 3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 Sanitary Waste Piping Specialties.
- W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- X. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 Sleeves and Sleeve Seals for Plumbing Piping.
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220517 Sleeves and Sleeve Seals for Plumbing Piping.
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 Escutcheons for Plumbing Piping.

3.3 OINT CONSTRUCTION

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

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:

- a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
- b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
 - 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
 - 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

- A. Comply with requirements in Section 220523.12 Ball Valves for Plumbing Piping, Section 220523.13 Butterfly Valves for Plumbing Piping, Section 220523.14 Check Valves for Plumbing Piping, and Section 220523.15 Gate Valves for Plumbing Piping for general-duty valve installation requirements.
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Comply with requirements for backwater valve specified in Section 221319 Sanitary Waste Piping Specialties.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 Hangers and Supports for Plumbing Piping and Equipment. Section 220548.13 Vibration Controls for Plumbing Piping and Equipment.
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

- 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- F. Support vertical runs of cast iron soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. All horizontal piping 5" and larger branch openings, or changes in direction shall be suitably restrained to prevent movement of joints and possible separation. Restraints can be field fabricated, or pre-engineered and manufactured.
- H. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Install horizontal backwater valves with cleanout cover flush with floor.
 - 6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 Sanitary Waste Piping Specialties.
 - 7. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main.
 - 2. Sewage Pump: To sewage pump discharge.

- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 Identification for Plumbing Piping and Equipment.

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.

- 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
- 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PREVENTIVE MAINTENANCE

- A. All piping coming from parking deck drains shall be flushed with clean water for not less than 10 minutes in each drain after winter season, and every 120 days. If chemicals are used to clean garage walls, this chemical shall be washed off the exterior of the pipe.
- B. All piping from dedicated soda station floor sinks shall be flushed by dumping a basin of 5 gallons of warm clean water every 3rd day into the floor sink.

C. All piping connected to "low flow" fixtures shall be flushed with clean water by filling, and releasing a utility wash basin sink from the furthest point possible not less than once every 7 days.

3.12 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
 - 1. Solid Wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, vent piping NPS 4 and smaller shall be the following:
 - 1. Solid Wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
 - 1. Solid Wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 22 13 16

Section 22 13 19 - Sanitary Waste Piping Specialties

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Miscellaneous sanitary drainage piping specialties.
 - 6. Flashing materials.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS - GENERAL

- A. All floor drains shall be constructed of cast iron and shall be complete with clamping devices as required. The following numbers are taken from the osam Catalog: Equivalent drains as manufactured by .R. Smith, Zurn or Wade will be acceptable. NO OTHER MANUFACTURERS WILL BE ACCEPTED WITHOUT PRIOR APPROVAL. All floor drains shall be provided with 2# lead flashing extending a minimum of 24 all around drain except in certain areas where the General Contractor is providing a flashing membrane, in which case that membrane shall be flashed into the drain.
- B. All floor drains shall be installed with deep seal p-traps.

2.2 CLEANOUTS:

- A. Cleanouts other than type listed below as manufactured by .R. Smith, osam, Zurn and Wade, will not be acceptable.
- B. Cleanouts shall be provided where shown on plans, at each change of direction of the building drain greater than 45 degrees and at or near the foot of each vertical waste or soil stack. Location of all cleanouts shall be the same size as the piping. Every cleanout shall be installed so that the cleanout opens in the direction of the flow of the drainage line or at right angle thereto.
- C. Floor cleanouts shall be an adjustable type with anchor flange for clamp device, clamping collar and nickel bronze cover. Contractor shall install 2# lead flashing a minimum of 18 all around cleanout and flash into flange and anchor with clamping collar.
- D. Top of cleanout shall be level with top of finished floor so there is a continuous surface.
- E. Floor cleanouts shall be Zurn 1400, Wade W-6000, or .R. Smith 4031 (NB) with adjustable scoriated secured nickel bronze top.
- F. Wall cleanouts shall be nickel bronze access frame and cover, osam 58770, Wade W-8560-E with W-8303-1, . R. Smith 4735 access cover.
- G. Outside cleanouts shall be as detailed on the Plans.

2.3 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 - 1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Firestop Assemblies:
 - 1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
 - 2. Size: Same as connected soil, waste, or vent stack.
 - 3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - 4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - 5. Special Coating: Corrosion resistant on interior of fittings.

2.5 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- E. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- F. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.

3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. oin flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

- 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
- 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
- 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 Sheet Metal Flashing and Trim.
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into castiron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.3 **PROTECTION**

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

END OF SECTION 22 13 19

Section 22 14 13 – Facility Storm Drainage Piping

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products 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.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, Plastics Piping System Components and Related Materials, for plastic piping components. Include marking with NSF-drain for plastic drain piping.

1.6 PRO ECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 PVC PIPE AND FITTINGS

- A. Solid-Wall Schedule 40 PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe is **not acceptable**.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 - 3. Shielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- . Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- . Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- M. Install cast-iron soil piping according to CISPI's Cast Iron Soil Pipe and Fittings Handbook, Chapter IV, Installation of Cast Iron Soil Pipe and Fittings.
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- N. Install aboveground PVC piping according to ASTM D 2665.

- O. Install underground PVC piping according to ASTM D 2321.
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors.
- R. Install sleeve seals for piping penetrations of concrete walls and slabs.
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 OINT CONSTRUCTION

- A. Plastic, Nonpressure-Piping, Solvent-Cemented oints: Clean and dry joining surfaces. oin pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: oin according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.6 IDENTIFICATION

A. Identify exposed storm drainage piping.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 48 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

- 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
- 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during the remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Underground, storm drainage piping shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 22 14 13

Section 22 34 00 – Fuel-Fired Domestic Water Heaters

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, Service Water Heating.
- C. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.

- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. 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.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, Drinking Water System Components Health Effects.

1.7 COORDINATION

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

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of 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. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: One year(s).

b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
 - 1. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - a. <u>Rheem Manufacturing Company</u>.
 - b. <u>State Industries</u>.
 - 2. Standard: ANSI Z21.10.3/CSA 4.3.
 - 3. Description: Manufacturer's proprietary design to provide at least 88 **Insert number** percent combustion efficiency at optimum operating conditions.
 - 4. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 - 5. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. acket: Steel with enameled finish.
 - f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
 - g. Temperature Control: Adjustable thermostat.
 - h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
 - j. Venting: Standard power venting use 4" diameter schedule 80 CPVC vent and intake piping with concentric vent kit terminated thru the roof.

- B. Capacity and Characteristics:
 - 1. Capacity: 100 gal..
 - 2. Recovery: 223 gph at 80 deg F temperature rise.
 - 3. Temperature Setting: 140 deg F.
 - 4. Fuel Gas Demand: 150 cfh.
 - 5. Fuel Gas Input: 150,000 Btu/h.
 - 6. Gas Pressure Regulator:
 - a. Capacity: 150 cfh.
 - b. Inlet Pressure: 3.5 14 inches water column.
 - c. Gas Pressure Required at Burner: 3.5 14 or inches water column.
 - 7. Electrical Characteristics:
 - a. Volts: 120.
 - b. Phase: Single.
 - c. Hertz: 60.
 - 8. Minimum Vent Diameter: 4 inches.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
 - 1. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - a. Watts
 - b. Zurn
 - c. <u>Wessels</u>
 - 2.
 - 3. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butylrubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 4. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 5. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig.
 - b. Capacity Acceptable: 4.5 gal. minimum.
 - c. Air Precharge Pressure: .
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Manifold its: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.
- F. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 Ball Valves for Plumbing Piping, Section 220523.13 Butterfly Valves for Plumbing Piping, and Section 220523.15 Gate Valves for Plumbing Piping.
 - 1. Comply with requirements for balancing valves specified in Section 221119 Domestic Water Piping Specialties.
- G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- H. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.
- I. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- . Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- . Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- L. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
- M. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- N. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and onehalf times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 Quality Requirements for retesting and reinspecting requirements and Section 017300 Execution for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified.
 - 1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. 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.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. 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.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestichot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 Ball Valves for Plumbing Piping, Section 220523.13 Butterfly Valves for Plumbing Piping, and Section 220523.15 Gate Valves for Plumbing Piping.
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 - 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 - 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 - 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 Facility Natural-Gas Piping.
- D. 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.
- E. 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. Comply with requirements for hose-end drain valves specified in Section 221119 Domestic Water Piping Specialties.

- F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 Meters and Gages for Plumbing Piping.
- G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 Ball Valves for Plumbing Piping, Section 220523.13 Butterfly Valves for Plumbing Piping, and Section 220523.15 Gate Valves for Plumbing Piping, and comply with requirements for thermometers specified in Section 220519 Meters and Gages for Plumbing Piping.
- H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- I. Fill domestic-water heaters with water.
- . Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section 221116 Domestic Water Piping.
- B. Comply with requirements for gas piping specified in Section 231123 Facility Natural-Gas Piping.
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 Identification for Plumbing Piping and Equipment.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 Quality Requirements for retesting and reinspecting requirements and Section 017300 Execution for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 22 34 00

Section 22 42 00 - Plumbing Fixtures

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Water closets.
 - 3. Flush valves.
 - 4. Toilet seats.
 - 5. Lavatories.
 - 6. Sinks.
 - 7. Hose bibs.
 - 8. Electric Water Cooler.
 - 9. Ice Machine Connection.
 - 10. Refrigerator water connection box.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each of the plumbing fixtures.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flush valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 REFER TO PLUMBING FIXTURE SCHEDULE ON DRAWINGS FOR ADDITIONAL INFORMATION.

2.2 BAC FLOW PREVENTERS MAINTENANCE / FIELD TESTING:

A. Back preventers shall be check and field installed by a Backflow Prevention Assembly Tester who meets ASSE 5000 Professional Qualification Standard, or other individuals holding a testing certificate from a nationally recognized backflow certification organization approved by the Plumbing Official.

- B. Backflow prevention devices shall be field tested upon installation and annually. Contractor shall submit certification of test and written report of test results on each backflow preventer. Test on backflow preventer shall be completed in accordance with local and state requirements.
- C. DOUBLE CHECK BACKFLOW PREVENTER (6"): (Fire Main Sprinkler System)
 - 1. Ames Colt Series C300-OSY, (Wilkens 350DA, Watts 757DCDA-OSY) Double Check Detector Assembly backflow preventer, with two (2) OS Y resilient wedge gate valves with tamper switch for each OS Y valve, and bypass assembly with double check assembly. ASSE 1048. Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California for horizontal and vertical installation.

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 walls and floors for suitable conditions where plumbing fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Refer to Architectural Drawings for mounting height and exact location of all plumbing fixtures. Handicapped fixtures shall be installed to meet the latest A.D.A. requirements.

3.3 QUALITY

- A. Plumbing Contractor shall furnish and install all plumbing fixtures shown on accompanying Drawings. Refer to both Plumbing and Architectural, and provide all fixtures shown on either. Fixtures shall be complete with all necessary brass and accessories required for a complete installation, including traps, escutcheons, angle supplies, basin cocks, etc. All fixtures shall be new and must be delivered to the building properly crated in perfect condition.
- B. All brass must be of the best quality. Lightweight goods will not be accepted.
- C. All brass pipe shall be seamless brass tubing and nipples shall be extra heavy.
- D. All fittings and trim shall be chromium plated heavy brass unless otherwise specified.
- E. P traps on lavatories and sinks shall be cast brass with cleanouts.
- F. All exposed piping shall be chromium plated.
- G. Provide cut-off valves at each fixture in both hot and cold water piping.
- H. For the purpose of establishing type and class of fixtures required, the following plate numbers have been taken from the Manufacturer's Catalog as indicated: Other fixture manufacturer's and model numbers,

with prior approval, will be acceptable, however fixtures and accessories shall meet standards and features indicated below.

- I. Contractor shall install silicon caulk around the base of a plumbing fixture or around the perimeter of a plumbing fixture where it attaches to a wall. The color of the caulk shall match the color of the plumbing fixture or shall be a color selected by the architect. Verify final color prior to installation. Caulked joint shall be properly smoothed out and shall completely seal the joint between the plumbing fixture and the surface the fixture is attached to. Unacceptable applications shall be completely removed and re-applied in accordance with directions from the architect.
 - Water-Closet Installation:
 - 1. Install level and plumb according to roughing-in drawings.
 - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
 - 3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
 - Support Installation:
 - 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
 - 2. Use carrier supports with waste-fitting assembly and seal.
 - 3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto wastefitting seals; and attach to support.
 - 4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
- L. Flushometer-Valve Installation:
 - 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
 - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
 - 4. Install actuators in locations that are easy for people with disabilities to reach.
 - 5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- M. Install toilet seats on water closets.
- N. Wall Flange and Escutcheon Installation:
 - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 - 3. Comply with escutcheon requirements specified in Section 220518 Escutcheons for Plumbing Piping.
- O. oint Sealing:
 - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildewresistant silicone sealant.
 - 2. Match sealant color to water-closet color.
 - 3. Comply with sealant requirements specified in Section 079200 oint Sealants.

3.4 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

- B. Comply with water piping requirements specified in Section 221116 Domestic Water Piping.
- C. Comply with soil and waste piping requirements specified in Section 221316 Sanitary Waste and Vent Piping.
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.5 AD USTING

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

3.6 CLEANING AND PROTECTION

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

END OF SECTION 22 42 00

Section 23 00 00 – Mechanical General Provisions

PART 1 GENERAL

1.01 SUMMARY



A. The General Conditions of the Architectural Specifications, along with the supplementary conditions, special conditions, information to bidders, and any other pertinent information and documents shall apply the same as if repeated herein.

1.02 SCOPE OF WOR

- A. Furnish all labor and material necessary to provide and install the complete mechanical portion of this Contract, including HVAC systems as called for herein and on accompanying drawings. Parts of the mechanical division may be bid separately or in combination, at the Contractor's option; however, it shall be the responsibility of the General Contractor to assure himself that all items covered in the this Division have been included if he chooses to accept separate bids.
- B. This Contractor shall refer to the Architectural and Structural drawings and install equipment, piping, etc. to meet building and space requirements. No equipment shall be bid on or submitted for approval if it will not fit in the space provided.
- C. It is the intention of these Specifications that all mechanical systems shall be furnished complete with all necessary valves, controls, insulation, piping, devices, equipment, etc. necessary to provide a satisfactory installation in working order.
- D. Contractor shall visit the site and acquaint himself thoroughly with all existing facilities and conditions that would affect his portion of the work. Failure to do so shall not relieve the Contractor from the responsibility of installing his work to meet the conditions.
- E. This Contractor shall protect the entire system and all parts thereof from injury throughout the project and up to acceptance of the work. Failure to do so shall be sufficient cause for the Architect to reject any piece of equipment.

1.03 DEMOLITION

- A. The contractor shall visit the site prior to bid to determine the extent of work required to complete the project.
- B. Contractor shall coordinate demolition with owner. The Owner shall have "First Right of Refusal" regarding salvage of all equipment and materials to be removed. Locate equipment as directed by owner. All equipment and materials not salvaged by the owner shall be removed from the site and discarded at the contractor's expense.
- C. Contractor shall coordinate all work with general contractor and phase work as required by project.
- D. All equipment piping, etc. required to be removed to accommodate the modifications shall be removed.

- E. Contractor shall maintain services to existing facilities which shall remain during and after construction is complete.
- F. Contractor shall coordinate any shutdown of services with the owner. It is intended that the building will remain occupied during construction. Contractor shall schedule shut down of services with the owner in order to prevent disruption of building occupancy.
- G. Contractor shall be responsible for draining down of existing systems to complete demolition. All work shall be scheduled with the owner. Contractor shall also be responsible for refilling system and removing all air in order to return the systems to proper operating conditions.
- H. All shut down of services shall be done at night or during a time period approved by the owner. The systems shall be required to be back up and running each morning unless otherwise approved by the owner.

1.04 GROUNDS AND CHASES

A. This Contractor shall see that all required chases, grounds, holes and accessories necessary for the installation of his work are properly built in as the work progresses; otherwise, he shall bear the cost of providing them.

1.05 CUTTING AND PATCHING

A. Initial cutting and patching shall be the responsibility of the General Contractor, with the Mechanical Contractor being responsible for laying out and marking any and all holes required for the reception of his work. No structural beams or joists shall be cut or thimbled without first receiving the approval of the Architect. After initial surfacing has been done, any further cutting, patching and painting shall be done at this Contractor's expense.

1.06 FILL AND CHARGES FOR EQUIPMENT

A. Fill and charge with materials or chemicals all those devices or equipment as required to comply with the manufacturer's guarantee or as required for proper operation of the equipment.

1.07 MACHINERY GUARDS

- A. This Contractor shall provide v-belt guards for each v-belt drive or other hazardous drive. The guard shall enclose the drive entirely and shall have a hole for taking a tachometer reading.
- B. Provide protective guard for belts, pulleys, gears, couplings, projecting set screws, keys and other rotating parts which are located such that a person might come in close proximity. Construct protective guard around angle iron frame, securely bolted to apparatus; comply with safety requirements. Install guard to completely enclose drives and pulleys and not interfere with lubrication of equipment. Provide 2 inch minimum diameter opening in fan belt guards housing for tachometer.

1.08 REPAIRING ROADWAYS AND WAL S

A. Where this Contractor cuts or breaks roadways or walks, in order to lay piping, he shall repair or replace these sections to meet the Architect's approval.

1.09 EXCAVATION AND BAC FILL

- A. Contractor shall perform all excavating necessary to lay the specified services. Perform excavation of every description and of whatever substance encountered to depths indicated or specified. Pile materials suitable for backfilling a sufficient distance from banks of trenches to prevent slides or caveins. Comply with OSHA requirements for excavation, trenching and shoring. Waste excavation materials, rubbish, etc. shall be carted away from the premises, as indicated. Remove water from trenches by pumping or other approved method, discharge at a safe distance from the excavation.
- B. Provide trenches of necessary width for proper laying of pipe and comply with latest publication of OSHA 2226 Excavating and Trenching Operations. Coordinate trench excavation with pipe installation to avoid open trenches for prolonged periods. Accurately grade bottoms of trenches to provide uniform bearing and support for each section of pipe on undisturbed soil or the required thickness of bedding material at every point along its entire length.
- C. Provide minimum 12 inches between outer surfaces and embankment or shoring, which may be used, when excavating for manholes and similar structures. Remove unstable soil that is incapable of supporting the structure in the bottom of the excavation to the depth necessary to obtain design bearing.
- D. Material to be excavated is "unclassified". No adjustment in the contract price will be made on account of the presence or absence of rock, shale, masonry, or other materials.
- E. Protect existing utility lines that are indicated or the locations of which are made known prior to excavating and trenching and that are to be retained. Protect utility lines encountered during excavating and trenching operations, from damage during excavating, trenching and backfilling; if damaged, repair lines as directed by utilities, owner and A/E. Issue notices when utility lines that are to be removed are encountered within the area of operations in ample time for the necessary measures to be taken to prevent interruption of the service.
- F. Underground piping shall have a 6 bed of sand below the piping and backfilled with sand to 6 above the top of piping. Select fill may be used above the sand layer.
- G. Backfill trenches after piping, fittings and joints have been tested and approved. Backfill trenches with sand to provide 6 inches of sand below piping and 12 inches of sand cover above piping.
- H. Backfill remainder of trenches with satisfactory material consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones not over 1-1/2 inches in size. Deposit backfill material in 9 inch maximum layers, loose depth as indicated or as specified. Take care not to damage utility lines.
- I. Deposit the remainder of backfill materials in the trench in 1 foot maximum layers and compact by mechanical means. Refer to architectural for minimum density for compaction (Minimum 85 percent of maximum soil density as determined by ASTM D 698). Re-open trenches and excavation pits improperly backfilled or where settlement occurs to the depth required to obtain the specified compaction, the refill and compact with the surface restored to the required grade and compaction.
- . Backfill utility line trench with backfill material, in 6 inch layers, where trenches cross streets, driveways, building slabs, or other pavement. Moisten each layer and compact to 95 percent of the maximum soil density as determined by ASTM D 698. Accomplish backfilling in such a manner as to permit the rolling and compaction of the filled trench with the adjoining material to provide the required bearing value so that paving of the area can proceed immediately after backfilling is complete.

1.10 WELDING

A. Weld piping and above grade steel tanks in accordance with qualified procedures using performance qualified welders and welding operators. Qualified procedures and welders in accordance with ASME Section IX. Welding procedures qualified by others and welders and welding operators qualified by another employer may be accepted as permitted by ANSI B31.1. Notify the A/E 24 hours in advance of tests, and perform the tests at the work site if practicable. Furnish A/E with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Apply welders or welding operators assigned symbols near each weld they make as permanent record.

1.11 NOISE AND VIBRATION

A. Provide the plumbing system and its associated components, items, piping, and equipment free of objectionable vibration or noise. Statically and dynamically balance rotating equipment and mount or fasten so that no vibration is transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions at no additional compensation.

1.12 PAINTING

- A. All painting shall be by the General Contractor's Painting Sub-Contractor. All pipe, pipe covering, equipment, supports, hangers, etc. exposed in the building or equipment room shall be painted. This Contractor shall prepare the surface of the material to receive the first coat of paint.
- B. All steel hydronic piping shall have two (2) coats of rust inhibitor primer applied prior to insulating.
- C. All subsequent coatings shall be prepared by the Painting Sub-Contractor. Requirements covering paints, workmanship and preparation of surfaces as stated in the Architectural Specifications shall govern. Colors shall be approved by the Architect. All piping shall be color-coded.
- D. All piping shall be color coded per the following: 1. Ductwork (Exposed in Building)

Black

1.13 CLEANING AND AD USTING

A. Upon completion of his work, the Contractor shall clean and adjust all equipment, controls, valves, etc.; clean all piping, ductwork, etc.; and leave the entire installation in good working order.

1.14 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Provide the Owner with three (3) copies of printed instructions indicating various pieces of equipment by name and model number, complete with parts lists, maintenance and repair instructions and test and balance report.
- B. COPIES OF SHOP DRAWINGS WILL NOT BE ACCEPTABLE AS OPERATION AND MAINTENANCE INSTRUCTIONS BUT MUST BE INCLUDED IN SUBMITTAL PAC AGE.
- C. This information shall be bound in plastic hardbound notebooks with the job name permanently embossed on the cover. Rigid board dividers with labeled tabs shall be provided for different pieces of equipment. Submit manuals to the Architect for approval.
- D. In addition to the operation and maintenance brochure, the Contractor shall provide a separate brochure which shall include registered warranty certificates on all equipment, especially any pieces of equipment which carry warranties exceeding one (1) year.

E. The operation and maintenance brochure shall be furnished with a detailed list of <u>all</u> equipment furnished to the project, including the serial number and all pertinent nameplate data such as voltage, amperage draw, recommended fuse size, rpm, etc. The Contractor shall include this data on <u>each</u> piece of equipment furnished under this contract.

1.15 GUARANTEE

A. The Contractor shall guarantee all materials, equipment and workmanship for a period of one (1) year from the date of final acceptance of the project. This guarantee shall include furnishing of all labor and material necessary to make any repairs, adjustments or replacement of any equipment, parts, etc. necessary to restore the project to first class condition. This guarantee shall exclude only the changing or cleaning of filters. Warranties exceeding one (1) year are hereinafter specified with individual pieces of equipment.

1.16 LOCAL CONDITIONS

- A. The location and elevation of all utility services is based on available surveys and utility maps and are reasonably accurate; however, these shall serve as a general guide only, and the Contractor shall visit the site and verify the location and elevation of all services to his satisfaction in order to determine the amount of work required for the execution of the Contract.
- B. The Contractor shall contact the various utility companies, determine the extent of their requirements and he shall include in his bid all lawful fees and payments required by these companies for complete connection and services to the building, including meters, connection charges, street patching, extensions from meters to main, etc.
- C. In case major changes are required, this fact, together with the reasons therefor, shall be submitted to the Architect, in writing, not less than seven (7) days before the date of bidding. Failure to comply with this requirement will make the Contractor liable for any changes, additions and expenses necessary for the successful completion of the project.

1.17 PERMITS, INSPECTIONS AND TESTS

- A. All permits, fees, etc. for the installation, inspections, plan review, service connections locations, and/or construction of the work which are required by any authority and/or agencies having jurisdiction, shall be obtained and paid for by the Contractor. This shall be verified during the bidding process.
- B. The Contractor shall make all tests required by the Architect, Engineer or other governing authorities at no additional cost to the Owner.
- C. The Contractor shall notify the Architect and local governing authorities before any tests are made, and the tests are not to be drawn off a line covered or insulated until examined and approved by the authorities. In event defects are found, these shall be corrected and the work shall be retested.
- D. Prior to requesting final inspection by the Architect, the Contractor shall have a complete coordination and adjustment meeting of all of his sub-contractors directly responsible for the operation of any portion of the system. At the time of this meeting, each and every sequence of operation shall be checked to assure proper operation. Notify the Architect in writing ten (10) days prior to this meeting, instructing him of the time, date and whom you are requesting to be present.
- E. This project shall not be accepted until the above provisions are met to the satisfaction of the Architect.

1.18 CODES AND STANDARDS

- A. The entire mechanical work shall comply with the rules and regulations of the City, Parish, County and State in which this project is being constructed, including the State Fire Marshal and the State Board of Health. All modifications required by these authorities shall be made without additional charge to the Owners. The Mechanical Contractor shall report these changes to the Architect and secure his approval before work is started.
- B. In addition to the codes heretofore mentioned, all mechanical work and equipment shall conform to the applicable portions of the following specifications, codes and/or regulations:
 - 1. American Society of Heating, Refrigeration and
 - 2. Air Conditioning Engineers (ASHRAE)
 - 3. National Electrical Code (NEC)
 - 4. National Fire Protection Association (NFPA)
 - 5. American Society of Mechanical Engineers (ASME)
 - 6. American Gas Association (AGA)
 - 7. International Building Code (IBC)
 - 8. International Mechanical Code (IMC)
 - 9. International Plumbing Code (IPC)
 - 10. International Fuel Gas Code (IFGC)
 - 11. Underwriters Laboratories (UL)
 - 12. Life Safety Code (NFPA 101)
 - 13. State Sanitary Code
 - 14. Louisiana State Uniform Construction Code Council (LSUCCC)
- C. All materials, equipment and accessories installed under this Contract shall conform to all rules, codes, etc. as recommended by National Associations governing the manufacturer, rating and testing of such materials, equipment and accessories. All materials shall be new and of the best quality and first class in every respect. Whenever directed by the Architect, the Contractor shall submit a sample for approval before proceeding.
- D. Where laws or local regulations provide that certain accessories such as gauges, thermometers, relief valves and parts be installed on equipment, it shall be understood that such equipment be furnished complete with the necessary accessories, whether or not called for in these Specifications.
- E. All unfired pressure vessels shall be built in accordance with the A.S.M.E. Code and so stamped. Furnish shop certificates for each vessel.

1.19 REVIEW OF MATERIALS

- A. Whenever manufacturers or trade names are mentioned in these Plans or Specifications, the words or approved equivalent shall be assumed to follow whether or not so stated. Manufacturers or trade names are used to establish a standard of quality only, and should not be construed to infer a preference. Equivalent products which meet the Architect's approval will be accepted; however, these products must be submitted to the Architect a minimum of seven (7) days prior to the Bid Date.
- B. Submission shall include the manufacturer's name, model number, rating table and construction features.
- C. Upon receipt and checking of this submittal, the Architect will issue an addendum listing items which are approved as equivalent to those specified. THE CONTRACTOR SHALL BASE HIS BID SOLELY ON THOSE ITEMS SPECIFIED OR INCLUDED IN THE PRIOR APPROVAL ADDENDUM, AS NO OTHER ITEM WILL BE ACCEPTABLE.

- D. Prior approval of a particular piece of equipment does not mean automatic final acceptance and will not relieve the Contractor of the responsibility of assuring himself that this equipment is in complete accord with the Plans and Specifications and that it will fit into the space provided. Shop drawings must be submitted on all items of equipment for approval as hereinafter specified.
- E. Before proceeding with work and/or within thirty (30) days after the award of the General Contract for this work, the Mechanical Contractor shall furnish to the Architect complete shop and working drawings of such apparatus, equipment, controls, insulation, etc. to be provided in this project. These drawings shall give dimensions, weights, mounting data, performance curves and other pertinent information.
- F. The Architect's approval of shop drawings shall not relieve the Contractor from the responsibility of incorrectly figured dimensions or any other errors which may be contained in these drawings. Any omission from the shop drawings or specifications, even though approved by the Architect, shall not relieve the Contractor from furnishing and erecting same.
- G. If contractor submits hard copies, Six (6) sets of shop drawings shall be submitted to the Architect for approval. These submittals shall be supplied as part of this Contractor's contract.
- H. This information shall be bound in plastic hardbound notebooks with the job name on the cover. Rigid board dividers with labeled tabs shall be provided for different pieces of materials and equipment. Submit shop drawings to the Architect for approval. Faxed copies shall not be acceptable. We prefer electronic submissions sent via E-Mail.
- I. Required shop drawing submittals shall include but are not limited to the following:
 - 1. DX Split System Air Conditioning Equipment..
 - 2. Grilles, registers, diffusers and louvers.
 - 3. Ductwork and duct sealer.
 - 4. Duct insulation and accessories.
 - 5. Controls/Building Automation System.
 - 6. Exhaust fans.
 - 7. Unit heaters.
 - 8. itchen Hood
 - 9. Relief and intake hoods.
 - 10. Fire dampers
 - 11. Manual Dampers, Motorized Dampers and Control Dampers.
 - 12. Actuators.
 - 13. Test and Balancing Agency (including forms).

1.20 COORDINATION DRAWINGS

- A. Submit three (3) black line prints of all mechanical room layouts showing locations of all equipment, piping, etc. to insure all will fit in space provided. Submit drawings at 1/4 scale. Layouts shall include equipment submitted on project to scale on plans.
- B. Submit coordination drawings with the respective equipment shop drawings.

1.21 MINOR DEVIATIONS

A. Plans and detail sketches are submitted to limit, explain and define conditions, specified requirements, pipe sizes and manner of erecting work. Structural or other conditions may require certain

modifications from the manner of installation shown, and such deviations are permissible and shall be made as required. However, specified sizes and requirements necessary for satisfactory operation shall remain unchanged. It may be necessary to shift ducts or pipes, or to change the shape of ducts, and these changes shall be made as required. All such changes shall be referred to the Architect and Engineer for approval before proceeding. Extra charges shall not be allowed for these changes. The contractor shall obtain a full set of plans and specifications for the coordination of his work prior to bidding this project. Items which are unclear to the bidding contractor shall be brought to the Architect and Engineers attention prior to bidding the project. An interpretation shall be clarified by the Architect and/or the Engineer prior to bidding.

- B. The Contractor shall realize that the drawings could delve into every step, sequence or operation necessary for the completion of the project, without drawing on the Contractor's experience or ingenuity. However, only typical details are shown on the Plans. In cases where the Contractor is not certain about the method of installation of his work, he shall ask for details. Lack of details will not be an excuse for improper installation.
- C. In general, the drawings are diagrammatic and the Contractor shall install his work in a manner so that interferences between the various trades are avoided. In cases where interferences do occur, the Architect is to state which item was first installed.

1.22 AS-BUILT RECORD DRAWINGS

- A. The Contractor shall obtain at his cost, two sets of blackline prints of the original bid documents by the Architect. One set shall be kept on the site with all information as referenced below, and shall update same as the work progresses. The other set will be utilized to record all field changes to a permanent record copy for the Owner.
- B. If the Contractor elects to vary from the Contract Documents and secures prior approval from the Architect for any phase of the work, he shall record in a neat and readable manner, <u>ALL</u> such variances on the blackline print in red. The original blackline prints shall be returned to the Architect for documentation.
- C. All deviations from sizes, locations, and from all other features of the installations shown in the Contract Documents shall be recorded.
- D. In addition, it shall be possible using these drawings to correctly and easily locate, identify and establish sizes of all piping, directions and the like, as well as other features of the work which will be concealed underground and/or in the finished building.
- E. Locations of underground work shall be established by dimensions to columns, lines or walls, locating all turns, etc., and by properly referenced centerline or invert elevations and rates of fall.
- F. For work concealed in the building, sufficient information shall be given so it can be located with reasonable accuracy and ease. In some cases this may be by dimension. In others, it may be sufficient to illustrate the work on the drawings in relation to the spaces in the building near which it was actually installed. The Architect's/Engineer's decision in this matter will be final.
- G. The following requirements apply to all As-Built drawings:
 - 1. They shall be maintained at the Contractor's expense.
 - 2. All such drawings shall be done carefully and neatly, and in a form approved by the Archtect/Engineer.
 - 3. Additional drawings shall be provided as necessary for clarifications.
 - 4. These drawings shall be kept up-to-date during the entire course of the work and shall be available upon request for examination by the Architect/Engineer; and when necessary, to establish clearances for other parts of the work.
5. "As-built" drawings shall be returned to the Architect upon completion of the work and are subject to approval of the Architect/Engineer.

PART 2 PRODUCTS

2.01 HVAC SYSTEM PRODUCTS

A. Refer to individual Division 23 sections for mechanical products, controls, fans, pipe, tube and fitting materials and joining methods.

PART 3 EXECUTION

3.01 MANUFACTURER'S DIRECTION

A. The contractor shall install and operate all equipment and material in accordance with the manufacturer's installation and operating instructions. The manufacturer's instructions of installation and operation shall become part of the Contract Documents and shall supplement the Drawings and Specifications.

3.02 EQUIPMENT LABELS

A. Provide equipment labels for HVAC Equipment. Labels shall have permanent laminated construction secured to equipment.

3.03 PIPE LABELS

- A. Provide pipe markers and directional arrows on all piping in mechanical equipment rooms, or which is exposed in building, and on both sides of all valves located above ceiling. Markers shall be as manufactured by W.H. Bradley Co., Marking Services Inc. or the equivalent. All letters shall be color-coded and sized as recommended by OSHA. Samples of the type of letters to be used shall be submitted with shop drawings. Piping shall be color-coded.
- B. Pipe markers with arrows shall indicate lines content and shall be located 20 feet on center and at each change of direction of line. Identification bands shall be color coded to match pipe markers and shall be provided 10 feet on center. Pipe identification markers shall be taped at each end and shall be taped around the entire circumference of pipe.
- C. The following Piping shall be identified:
 - 1. Refrigerant Piping
 - 2. Condensate piping

3.04 VALVE TAGS

A. Secure metal tags to all valves. Labeling on all valve tags shall include type of system the valve controls and the area of building, zone, or equipment number affected by valve operation. Tag shall be 2 minimum diameter brass, engraved with code number, service and size. A framed list of the valves, giving manufacturer's name, model number, type and location shall be mounted in the main equipment room.

3.05 ACCESS DOORS:

- A. Provide access doors in walls, floors and ceilings to permit access to equipment and piping requiring service or adjustment.
 - 1. Valves.
 - 2. Manual balancing dampers and automatic control dampers.
 - 3. Air terminal units and VRF indoor units.
 - 4. Duct mounted filters and coils.
 - 5. Drainage cleanouts.
 - 6. itchen Hood exhaust ductwork in accordance with NFPA requirements.
 - 7. Equipment shutoff protection devices such as disconnects, motor rated switches, etc.
 - 8. Other mechanical equipment indicated in schedules or specifications which are requiring maintenance, adjustment or operation.
- B. Provide hinged access doors and frames as follows:
 - 1. Drywall Construction:
 - a. Provide with concealed spring hinges and flush screwdriver operated cam locks in sufficient number of the size of the panel.
 - b. Provide prime paintable surface (not galvanized).
 - c. Product: Milcor "Style M" (Karp DSC-214M).
 - 2. Visible Masonry and Ceramic Tile:
 - a. Milcor "Style M" (Karp DSC-214M).
 - 3. Cement Plaster:
 - a. Milcor "Style K" (KarpDSC-214 PL).
 - 4. Acoustical Plaster:
 - a. Reinforced panel as required to prevent sagging. Provide continuous steel piano type hinge for the length of the panel, and sufficient number for the size of the panel. Provide factory prime paint surface (not galvanized).
 - b. Product: Milcor "Style AP" (Karp 214 PL).
 - 5. Acoustical Tile:
 - a. Milcor "Style AT" (Larsen L-CPA).

- C. Provide continuous concealed hinges and cam locks.
- D. Provide UL listed 1-1/2 hour label "B" access doors with automatic self-closing latching mechanism where required.
- E. Provide removable ceiling access tile section immediately adjacent to each mechanical or electrical device located in the ceiling plenum above removable tile ceiling.
- F. Coordinate approval of type, color and location of access doors frames with Architect.

3.06 CLEANING AND SERVICE

- A. Upon Completion of this work, the contractor shall clean and adjust equipment, controls, valves, etc.;
- B. Inspect, clean and service air filters and strainers immediately prior to final acceptance of project.
- C. Provide complete and working charge of proper refrigerant, free of contaminants, into each refrigerant system. After each system has been in operation long enough to ensure completely balanced condition, check the charge and modify it for proper operation as required.
- D. Place mechanical systems in complete working order. Clean equipment and piping materials thoroughly returning to "as new" condition prior to request for substantial completion.
- E. Remove excess materials and debris from mechanical rooms and drain pans. Broom clean areas. Thoroughly clean ductwork inside and outside before air devices (diffusers, grilles, etc.) are installed.

3.07 TEMPORARY HEATING AND AIR CONDITIONING DURING CONSTRUCTION PHASE

- A. Permanent building air conditioning equipment or systems are not designed to control building temperature and humidity levels during construction of the building. The building's HVAC system is not designed nor is it well suited for the proper drying of building/construction materials, and should not be used for such purposes.
- B. At all times, during construction phases, provide temporary ventilation both for comfort and protection of workers, for proper drying of wet work, and for proper curing of installed materials. Follow material manufacturer's published instructions with regard to installation of building materials.
- C. Provide temporary heat both for the comfort and protection of workers and as necessary to ensure suitable working conditions for construction operations of construction trades, and also as necessary for storage of products and materials. Refer to material manufacturer's literature for environmental operational temperature and humidity requirements.
- D. Provide temporary heat by use of self-contained, vented portable heating units, employing tanked gas or other approved heat source.
- E. Use only heating apparatus and fuels labeled or listed by a "National Recognized Testing Laboratory" recognized by OSHA. eep equipment and surroundings in clean, safe conditions.
- F. Use flame resistant tarpaulins other material for temporary enclosures of space.

- G. Provide temporary humidity control by the use of small incremental de-humidifiers, packaged desiccant type de-humidifiers, and/or packaged DX type air conditioners.
- H. Do not permit space temperatures to reach or fall to a level which will cause damage to work. Coordinate the temperature and humidity requirements with the manufacturer of the finishes being provided.
- I. Replace interior or exterior surfaces damaged by the use of temporary heaters with new materials or refinish at no additional expense to the owner.
- As soon as practical after permanent heating, ventilation, and air conditioning systems are in place and operable, the contractor at his option, may provide heat from the permanent building heating system, until such time that the building is complete. It is recommended that the building's permanent heating and air conditioning systems not be utilized to maintain temperature and humidity conditions within the building during the construction phase. Small space heaters and portable de-humidifiers are suggested as sources of temperature and humidity control. It is the intent that the permanent HVAC systems should not be used to condition or control humidity during construction.
- The use of permanent HVAC systems will require that the systems be complete and fully controllable by the Building Automation System (BAS) including the ability to remotely alarm proper maintenance personnel in the event of any and all system failure(s) or inability to maintain setpoint temperatures and humidity levels. Should the contractor elect to utilize the building's permanent HVAC system, the contractor shall bring the HVAC systems and ductwork back to an original unused condition or state by thoroughly cleaning and/or repairing both equipment and ductwork including repair and refinishing scrapes, tears, scratches and dents, cleaning ductwork, cleaning AHU coils, etc.
- L. All dust, dirt, fungal growth, and debris in duct work shall be cleaned.
- M. All disposable or wearable parts such as belts, filters, etc., shall be replaced without option or cause.
- N. Contractor's Use of Permanent HVAC Systems:
 - 1. Heating System:
 - a. Should the contractor (at his option and at his own risk), utilize the building's permanent heating systems provided under this contract to provide space heating prior to project completion date subject to the restraints stated herein.
 - b. The fuel for such space heating and for required tests of heating equipment shall be provided by contractor.
 - c. The start up of equipment for use by the contractor shall not commence any warranty period.
 - d. The heating system shall be operated only by qualified personnel, and shall be operated with all auxiliaries, safeties, and in accordance with manufacturer's instructions and good operating practice.
 - e. If at any time the Owner's Representative determines that the equipment is being improperly operated or maintained, contractor will be directed to disconnect its use.
 - f. Heating systems shall be operated and controlled to prevent temperature in any room or space in any building from exceeding 90 deg. F.

- g. Temperature controls shall be functional to the extent that the operating temperatures of equipment, ductwork piping, etc., shall not either fall or be elevated above or below normal operating limits. The contractor shall demonstrate to the owner or his representative the ability of the system to be controlled, including limit alarms installed and the ability to monitor the systems off-site.
- h. Systems shall not be operated unattended such as on holidays, weekends, nights, etc, nor shall personnel unfamiliar with the operation of the HVAC Systems be employed to "monitor or attend to" the systems such as security personnel, or janitorial staff. The heating system, when in operation, shall be continuously monitored by the mechanical contractor's approved personnel.
- i. Systems when activated, may be placed into operation without diffusers and registers in place, but filters capable of filtering gypsum dust or other associated construction dust and debris shall be provided both in air handling equipment and at return air grille locations. Filter all return air entering duct work, to prevent return air ductwork from accumulating dust or otherwise becoming dirty.
- j. Prior to final acceptance of the work, the contractor shall place heating systems and related equipment in a condition equal to new in that contractor shall clean all ductwork, coils, equipment, etc.
- k. All disposable or wearable parts such as belts, filters, etc., shall be replaced without option or cause.
- 2. Preliminary Heating Test, Adjusting and Balancing Report:
 - a. Provide a TAB report at the time the heating system(s) start-up which shall indicate the following conditions:
 - 1) Air pressure drop across the unit filters
 - 2) Air pressure drop across the unit's cooling coil(s)
 - 3) Air pressure drop across the unit's heating coil(s)
 - 4) Total static pressure produced by the unit
 - 5) Discharge air static pressure
 - 6) Fan RPM
 - 7) Suction air pressure
 - 8) Provide a unit pressure graph
 - 9) Discharge air temperature (each air moving device)
 - 10) Return air temperature (each air moving device)
 - 11) Entering water temperatures (hot chilled)
 - 12) Leaving water temperatures (hot chilled)
 - 13) Water flow quantity (gpm) through the coil(s)(hot chilled)
- 3. Air Conditioning System:
 - a. Should the contractor (at his option and at his own risk), utilize the building's permanent air conditioning systems provided under this contract to provide space cooling and de-humidification prior to the project completion date. As such, any damages, loss of performance, wear, and other detrimental effects caused by the operational performance characteristics of the A/C system such as condensation, sweating of grilles, registers, diffusers, ducts, equipment, walls, floors, ceilings, and other conditions which may cause damage to building

components or which cause mold, mildew, etc., shall be the total responsibility of the contractor.

- b. The fuel, electricity or other energy required for space cooling and for any subsequent operation or testing shall be provided by the Contractor.
- c. The cooling system(s) shall be operated only by fulling qualified personnel and shall be operated with all safety auxiliaries, and in accordance with manufacturer's instructions and good operating practice.
- d. Start-up of equipment for use by the Contractor shall not commence any warranty period.
- e. If at any time the Owner's Representative determines that the equipment is being improperly operated or maintained, the contractor will be directed to discontinue and disconnect its use and the contractor will be required to provide portable units to maintain space temperatures.
- f. Temporary cooling and/or de-humidification systems shall be operated and controlled to prevent temperature and humidity in any room or space in any portion of the building from falling below 75 deg. F or above 65 relative humidity.
- g. Temperature controls shall be functional to the extent that the operating temperatures of equipment, ductwork, piping, etc., shall not fall below the normal stated "design" operating limits. The contractor shall demonstrate to the owner or his representative the ability of the system to be controlled, including limit alarms installed and the ability to monitor the systems off-site.
- h. Insulation systems for all piping, ductwork, etc., shall be completely installed prior to use of the permanent systems.
- i. Systems shall not be operated unattended such as on holidays, weekends, nights, etc., nor shall personnel unfamiliar with the operation of the HVAC Systems be employed to "monitor or attend to" the systems such as security personnel, or janitorial staff. The air conditioning system when in operation, shall be continuously monitored by the mechanical contractor's approved personnel.
- j. Systems when activated, may be placed into operation without diffusers and registers in place, but filters capable of filtering gypsum dust or other associated construction dust and debris shall be provided both in air handling equipment and at return air grille locations. Filter all return air entering duct work, to prevent return air duct work from accumulating dust or otherwise becoming dirty.
- k. Contractor shall, prior to final acceptance of the work, place cooling systems and related equipment in a condition equal to new in that contractor shall clean all ductwork, coils, equipment, etc.
- 1. All disposable or wearable parts such as belts, filters, etc., shall be replaced without option or cause.
- 4. Preliminary Air Conditioning Test, Adjusting and Balancing Report:
 - a. Provide a TAB report at the time the heating system(s) start-up which shall indicate the following conditions:

- 1) Air pressure drop across the unit filters
- 2) Air pressure drop across the unit's cooling coil(s)
- 3) Air pressure drop across the unit's heating coil(s)
- 4) Total static pressure produced by the unit
- 5) Discharge air static pressure
- 6) Fan RPM
- 7) Suction air pressure
- 8) Provide a unit pressure graph
- 9) Discharge air temperature (each air moving device)
- 10) Return air temperature (each air moving device)
- 11) Entering water temperatures (hot chilled)
- 12) Leaving water temperatures (hot chilled)
- 13) Water flow quantity (gpm) through the coil(s)(hot chilled)

END OF SECTION 23 00 00

Section 23 05 13 - Common Motor Requirements for HVAC Equipment

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
 - Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All materials and equipment shall be installed in accordance with Manufacturer's recommended installation methods for obtaining conformance with the Contract Documents.
- B. Alignment of all motors, factory coupled or mounted, and all motors field coupled and mounted, shall be rechecked after all connections have been made and after 48 hours of operation in designed service.
- C. Verify the voltage characteristics of each motor prior to ordering.
- D. Verify the correct wire connections and rotation of equipment by "bumping" motor after wiring.
- E. Confirm voltage imbalance on 3-phase motors is less than 2 .
- 3.2 APPLICATION: Except as specifically indicated, motors shall be selected as follows:

A. Phase:

- 1. Less than 1.0 HP: Single-Phase.
- 2. 1 HP and Larger: Three-phase.
- B. Single Phase Starting:
 - 1. 1/8 HP and Less: Split phase or permanent split capacitor.
 - 2. Greater than 1/8 HP: Capacitor start.
- C. Enclosure:
 - 1. Totally enclosed fan-cooled (TEFC) for all motors located outside above roof, in wet areas, in mechanical rooms, or elsewhere as indicated.
 - 2. Open drip-proof (ODP) for motors located elsewhere, in a clean, dry environment.

END OF SECTION 23 05 13

Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Metal pipe hangers and supports.
- 2. Trapeze pipe hangers.
- 3. Metal framing systems.
- 4. Thermal-hanger shield inserts.
- 5. Fastener systems.
- 6. Pipe stands.
- 7. Equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1.
 - 2. Manufacturers:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Flex-Strut Inc.
 - c. Thomas Betts Corporation, A Member of the ABB Group.
 - d. Unistrut; an Atkore International company.
 - e. Wesanco, Inc.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with inturned lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 7. Metallic Coating: Electroplated zinc.

2.4 FASTENER SYSTEMS

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

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
- B. Roof Sleepers for VRF outdoor condensing units: Pate Model ES-2 or equal, equipment rail supports, 18 ga. Galvanized steel, unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer, counterflashing with screws. Height of support shall be a minimum of 16 inches. Coordinate layout of supports with the equipment manufacturer's representative and equipment point loading requirements. Coordinate flashing and exterior insulation with the roofing installer and Architect.

2.6 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- . Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- . Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:

1.

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

3.2 EQUIPMENT SUPPORTS

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

3.3 METAL FABRICATIONS

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

3.4 AD USTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- E. Use thermal-hanger shield inserts for insulated piping and tubing.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

- 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
- 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
- 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
- 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
- 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
- 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
- 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
- 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
- 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
- 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
- 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
- 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
- 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
- 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
- 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
- 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

- 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 - 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 - 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
 - Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
 - Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 - 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 - 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 - 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

- 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION 23 05 29

Section 23 05 53 - Identification for HVAC Piping and Equipment

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:1. Equipment Labels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Manufacturer shall be one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. Emedco.
 - g. olbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products.
 - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 3. Letter Color: White.
 - 4. Background Color: Black.
 - 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- 8. Fasteners: Stainless-steel rivets.
- 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules).
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulated.

3.2 GENERAL INSTALLATION REQUIREMENTS

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

3.3 EQUIPMENT LABEL INSTALLATION

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

END OF SECTION 23 05 53

Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WOR

- A. The Contractor shall obtain the services of an independent Test and Balance (TAB) Company which specializes in the testing and balancing of heating, ventilating and air conditioning (HVAC) systems to test, adjust and balance all HVAC systems in the building(s).
- B. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC systems as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results. The testing, adjusting and balancing agency shall act as a reporting agency; that is, list and report each piece of equipment as to identification number, manufacturer, model number, serial number, proper location, specified performance, and report actual performance of all equipment as found during testing. The report is intended to be used during the life of the building as a ready reference indicating original conditions, equipment components, etc.
- C. Representatives of the Test and Balance Company shall visit the job site during installation of the HVAC equipment, piping and ductwork as required.
- D. Upon completion of the HVAC system installation, the Test and Balance Company shall perform all required testing and balancing with the full cooperation of the Contractor and his Sub-contractors. The Contractor shall make changes and/or adjustments to the HVAC system components that are required by the Test and Balance Company to accomplish proper balancing. The TAB agency shall not supply or install any materials or balancing devices such as pulleys, drives, belts, etc. All of this work is by the Contractor and shall be performed at no additional cost to the Owner.
- E. The test and balance report complete with a summary page listing all deficiencies shall be submitted to the Architect for review. If the Architect agrees with the report, he shall sign it and return it to the Contractor. The test and balance report must be complete and must be accepted by the Architect prior to acceptance of the project. Any outstanding test and balance items shall be placed on the punch list and a monetary value shall be assigned to them.
- F. After all deficiencies have been corrected the Architect shall sign the testing and balancing report, and the Test and Balance Company shall supply four (4) copies of the final and complete report to the Contractor for inclusion in the Operation and Maintenance Manuals.
- G. The Test and Balance Company shall obtain a copy of all HVAC related shop drawings from the contractor. The contractor shall provide a set of approved shop drawings to the TAB contractor within 30 days from receiving approved shop drawings.

- H. The items requiring testing, adjusting, and balancing include (but are not restricted to) the following:
 - 1. Air Systems:
 - a. Supply Fan AHU
 - b. Exhaust Fans
 - c. Zone Branch and main ducts
 - d. Diffusers, Registers, Grilles and Dampers
 - e. Coils (Air Temperatures)
 - 2. Duct leakage tests.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

- A. Certified TAB reports.
- B. Sample report forms.

1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC NEBB or TABB.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, Instrumentation.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 Air Balancing.
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 System Balancing.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flowcontrol devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, Fans and Systems, or in SMACNA's HVAC Systems Duct Design. Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- . Examine operating safety interlocks and controls on HVAC equipment.
- . Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.

- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's National Standards for Total System Balance 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, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors.
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' as-built duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.

- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- . Check for proper sealing of air-handling-unit components.
- . Verify that air duct system is sealed as specified.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 - 4. Mark all final settings.

- 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
- 6. Measure and record all operating data.
- 7. Record final fan-performance data.

3.6 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.8 DUCT LEA AGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.
- D. Ductwork that initially fails these tests shall be replaced, modified, resealed, etc. as required to meet the leakage requirement and then re-test to ensure compliance.

3.9 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Equipment with Fans: Plus or minus 10 percent.
 - 2. Exhaust Fans: Plus 10 percent.
 - 3. Outside Airflow: Plus 10 percent.
 - 4. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

- 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
- 2. Include a list of instruments used for procedures, along with proof of calibration.
- 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 14. Test conditions for fans performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- D. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.

- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave and amount of adjustments in inches.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- E. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- F. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

- G. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.11 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.
- B. Architect may randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as FAILED.
- D. If the number of FAILED measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 - 3. If the second verification also fails, the design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

3.12 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

Section 23 07 13 – Duct Insulation

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply, return, exhaust and outdoor air.
 - 2. Indoor, exposed supply, return, exhaust and outdoor air.
 - 3. Tops of supply air diffusers, grilles and plenum boxes.
 - 4. Mechanical Room Walls

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance, thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields as specified.
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Duct Insulation Schedule, General, Indoor Duct and Plenum Insulation Schedule, articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Fire Rated Insulation:
 - 1. Manufacturer shall be one of the following:
 - a. 3M FireMaster Fast Wrap 615 .
 - b. Thermal Ceramics FireMaster.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Manufacturer shall be one of the following:
 - a. Aeroflex, USA, Inc.
 - b. Armacell LLC.
- H. Fiber-Glass Blanket Insulation: Fiber-Glass bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FS jacket. Factory-applied jacket requirements are specified in Factory-Applied ackets Article.
 - 1. Manufacturer shall be one of the following:
 - a. Certainteed Corporation.
 - b. ohns Manville; a Berkshire Hathaway company.
 - c. nauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacture shall be one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Foster Brand.
- C. Fiber-Glass Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturer shall be one of the following:
 - a. Childers Brand.
 - b. Eagle Bridges Marathon Industries.
 - c. Foster Brand.
 - d. Mon-Eco Industries, Inc.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Manufacturer:

- a. Foster Brand.
- b. nauf Insulation.
- c. Vimasco Corporation.
- d. Childers.
- 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.
- 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- 5. Color: White.

2.4 SEALANTS

- A. FS and Metal acket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

2.5 FACTORY-APPLIED AC ETS

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

2.6 TAPES

- A. FS Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FS Tape Disks and Squares: Precut disks or squares of FS tape.

2.7 SECUREMENTS

- A. Bands:
 - 1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
 - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitordischarge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

- 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
- 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - d. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - e. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - f. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.8 WALL LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, Fibrous Glass Duct Liner Standard.
 - 1. Manufacturers shall be as follows:
 - a. Certainteed
 - b. Owens Corning
 - c. ohns Manville
 - d. nauf
 - 2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
 - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. eep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

- 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- . Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- E. Insulation Installation at Floor Penetrations:
 - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Seal penetrations through fire-rated assemblies.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

3.6 INSTALLATION OF FIBER-GLASS INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitordischarge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 - 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

- 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inchwide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 WALL LINER

- A. Apply on all mechanical room walls from floor to ceiling / deck.
 - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 - 3. Butt transverse joints without gaps, and coat joint with adhesive.
 - 4. Fold and compress liner in corners or cut and fit to ensure butted-edge overlapping.
 - 5. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

3.8 FIELD-APPLIED AC ET INSTALLATION

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

3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies.

3.10 FINISHES

- A. Insulation with AS, Glass-Cloth, or Other Paintable acket Material: Paint jacket with paint system identified below and as specified.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.
- 3.11 FIELD QUALITY CONTROL
 - A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - B. Perform tests and inspections.
 - C. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the Duct Insulation Schedule, General Article.
 - D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply air.
 - 2. Indoor, concealed return air.
 - 3. Indoor, concealed exhaust air.
 - 4. Indoor, concealed outdoor air.
 - 5. Indoor, return air plenum boxes.
 - 6. Indoor, tops of ceiling diffusers and grilles.
 - 7. Indoor, exposed supply air.
 - 8. Indoor, exposed return air.
 - 9. Indoor, exposed exhaust air.
 - 10. Indoor, exposed outdoor air.
 - 11. Mechanical Room Walls
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

- 2. Factory-insulated flexible ducts.
- 3. Factory-insulated plenums and casings.
- 4. Flexible connectors.
- 5. Vibration-control devices.
- 6. Factory-insulated access panels and doors.

3.13 DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- B. Concealed, round and flat-oval, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- D. Concealed, round and flat-oval, exhaust-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- E. Concealed, rectangular, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- F. Concealed, rectangular, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- G. Concealed, rectangular, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- I. Concealed, supply-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
 - Return air plenum boxes installation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
 - Tops of supply air diffusers and grilles insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.

- L. Exposed, rectangular, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- M. Exposed, rectangular, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- N. Exposed, supply-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- O. Exposed, return-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2.125 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Minimum installed R-value shall be R-6.0.
- P. Mechanical Room Wall Liner
 - 1. Wall Liner: Fibrous glass, Type I, 1 inch thick.

END OF SECTION 23 07 13

Section 23 07 19 - HVAC Piping Insulation

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping, indoors and outdoors.
 - 2. Refrigerant suction and hot-gas piping, indoors and outdoors.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified.
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Piping Insulation Schedule, General, Indoor Piping Insulation Schedule, and Outdoor, Aboveground Piping Insulation Schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Manufacturer shall be one of the following:
 - a. Armacell AP.
 - b. Aeroflex USA.
 - c. -Flex USA.

2.2 ADHESIVES

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

- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 - 1. Manufacturers shall be one of the following:
 - a. Childers Brand.
 - b. Eagle Bridges Marathon Industries.
 - c. Foster Brand.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 5. Color: White.

2.4 FIELD-APPLIED AC ETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal acket:
 - 1. Aluminum acket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Finish and thickness are indicated in field-applied jacket schedules.
 - b. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - c. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 - 2. At contractor's option, in lieu of 0.016 aluminum jacket, the contractor may use Venture Clad 1577CW multi-layered laminate coated, acrylic pressure sensitive adhesive jacket system.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. eep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- . Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- . Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 Penetration Firestopping for firestopping and fireresistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

- 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
- 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

3.7 FIELD-APPLIED AC ET INSTALLATION

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

3.8 PIPING INSULATION SCHEDULE, GENERAL

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

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping:

1.

- 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inches thick.

3.11 OUTDOOR, FIELD-APPLIED AC ET SCHEDULE

- A. Install jacket over insulation material.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Refrigerant Piping, Concealed: 1. None.
- D. Refrigerant Piping, Exposed:1. Aluminum, Smooth: 0.016 inch thick.

3.12 OUTDOOR, FIELD-APPLIED MASTIC SCHEDULE

- A. Install two layers of mastic over insulation material.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Condensate Piping, Concealed: 1. None.
- D. Condensate Piping, Exposed:1. Vapor-Barrier Mastic: Solvent based.

END OF SECTION 23 07 19

Section 23 21 14 – HVAC Condensate Piping

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
 1. Condensate-drain piping.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Copper Tube.
- B. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
 - 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, Building Services Piping, for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Condensate-Drain Piping: 140 deg F.

2.2 COPPER TUBE AND FITTINGS

A. DWV Copper Tubing: ASTM B 306, Type DWV.

2.3 OINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:
 - 1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
- B. Plastic-to-Metal Transition Unions:
 - 1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.5 DIELECTRIC FITTINGS

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

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- . Select system components with pressure rating equal to or greater than system operating pressure.
- . Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- M. Install shutoff valve immediately upstream of each dielectric fitting.
- N. Comply with requirements specified for identifying piping.

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements specified for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.

- 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE OINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered oints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's Copper Tube Handbook, using lead-free solder alloy complying with ASTM B 32.
- D. Brazed oints: Construct joints according to AWS's Brazing Handbook, Pipe and Tube Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Mechanically Formed, Copper-Tube-Outlet oints: Use manufacturer-recommended tool and procedure, and brazed joints.

END OF SECTION 23 21 14

Section 23 23 00 - Refrigerant Piping

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Refrigerant pipes and fittings.
- 2. Refrigerant piping valves and specialties.
- 3. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant pipe and refrigerant piping specialty.
- B. Shop Drawings:
 - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; pipe lengths, branch controller locations, valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
 - 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 3. Show interface and spatial relationships between piping and equipment.
 - 4. Calculate refrigerant volume based on actual pipe layout for each VRF system.
 - 5. Shop Drawing Scale: 1/8 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, Safety Code for Refrigeration Systems.
- B. Comply with ASME B31.5, Refrigeration Piping and Heat Transfer Components.

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type or ASTM B 280, Type ACR.
- B. Contractor may use pre-insulated refrigerant line sets provided and/or approved by the VRF equipment manufacturer.

2.3 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR Type L, annealed- or drawn-temper tubing and copper fittings with brazed joints.
- B. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wroughtcopper fittings with soldered joints.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- . Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- . Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- M. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

3.3 PIPE OINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered oints: Construct joints according to ASTM B 828 or CDA's Copper Tube Handbook.
- E. Brazed oints: Construct joints according to AWS's Brazing Handbook, Chapter Pipe and Tube.
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
 1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.

- 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
- 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
- 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
- 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
- 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
- 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
- 8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
- 9. NPS 4: Maximum span, 12 feet; minimum rod, 1/2 inch.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Performance Requirements Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
 - 4. For VRF Systems: Test all refrigerant systems with pressure and vacuum per manufacturers recommendations. Refrigerant lines shall be tested under 600 (Minimum) psi Nitrogen pressure (or as recommended by manufacture for refrigerant type being used in each system) for 24 hours using soap suds at joints to test for leaks. Contractor shall perform a vacuum test (triple pull down test) at 1500 Microns with nitrogen break, then 1000 microns with nitrogen break, then 500 microns disconnect vacuum pump and hold vacuum for one (1) hour (Maximum of 100-point rice within the one-hour time period). If any test fails, the contractor shall repair leak(s) and completely retest the piping systems(s) (Pressure and vacuum tests). Once all tests are passed, evacuate the system, and properly charge with Refrigerant.
 - 5.
- B. Prepare test and inspection reports.

3.6 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

END OF SECTION 23 23 00

Section 23 31 13 - Metal Ducts

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Single-wall rectangular ducts and fittings.
- 2. Single-wall round ducts and fittings.
- 3. Sheet metal materials.
- 4. Sealants and gaskets.
- 5. Hangers and supports.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible and performance requirements and design criteria indicated in Duct Schedule Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's HVAC Duct Construction Standards Metal and Flexible
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Adhesives.
 - 2. Sealants and gaskets.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible based on indicated static-pressure class unless otherwise indicated.

- B. Transverse oints: Select joint types and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 2-1, Rectangular Duct/Transverse oints, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's HVAC Duct Construction Standards Metal and Flexible, Figure 2-2, Rectangular Duct/Longitudinal Seams, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards Metal and Flexible.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Chapter 4, Fittings and Other Construction, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible.

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's HVAC Duct Construction Standards -Metal and Flexible, Chapter 3, Round, Oval, and Flexible Duct, based on indicated static-pressure class unless otherwise indicated.
- B. Transverse oints: Select joint types and fabricate according to SMACNA's HVAC Duct Construction Standards Metal and Flexible, Figure 3-1, Round Duct Transverse oints, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards Metal and Flexible.
 - 1. Transverse oints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 3-2, Round Duct Longitudinal Seams, for staticpressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's HVAC Duct Construction Standards Metal and Flexible, Figure 3-5, 90 Degree Tees and Laterals, and Figure 3-6, Conical Tees, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards Metal and Flexible.

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Duct Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Galvanized sheet metal for rectangular and round ductwork shall have a minimum gauge of 26.

2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, Fibrous Glass Duct Liner Standard.
 - 1. Manufacturers shall be as follows:
 - a. Certainteed
 - b. Owens Corning
 - c. ohns Manville
 - d. nauf
 - 2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
 - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible, Figure 7-11, Flexible Duct Liner Installation.
 - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 - 3. Butt transverse joints without gaps, and coat joint with adhesive.
 - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 - 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

- 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or Z profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
- 9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
- 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GAS ETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 4 inches.
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.
- C. Water-Based oint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).

- 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
- 8. Service: Indoor or outdoor.
- 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based oint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Base: Synthetic rubber resin.
 - 3. Solvent: Toluene and heptane.
 - 4. Solids Content: Minimum 60 percent.
 - 5. Shore A Hardness: Minimum 60.
 - 6. Water resistant.
 - 7. Mold and mildew resistant.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged oint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct oint O-Ring Seals:
 - 1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg staticpressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible, Table 5-1, Rectangular Duct Hangers Minimum Size, and Table 5-2, Minimum Hanger Sizes for Round Duct.
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's HVAC Duct Construction Standards Metal and Flexible unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- . 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.
- . Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements as specified for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWOR

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in Duct Schedule Article.
- B. If ducts are not listed in the "Duct Schedule" Article then seal unlisted ducts to the following seal classes according to SMACNA's HVAC Duct Construction Standards Metal and Flexible :
 - 1. Ducts:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible, Chapter 5, Hangers and Supports.
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible, Table 5-1, Rectangular Duct Hangers Minimum Size, and Table 5-2, Minimum Hanger Sizes for Round Duct, for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for branch, outlet and inlet, and terminal unit connections.

3.6 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.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's HVAC Air Duct Leakage Test Manual. Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than **3-Inch wg**:
 - 1) Test representative duct sections totaling no less than **25 percent** of total installed duct area for each designated pressure class.
 - b. Exhaust Ducts with a Pressure Class of **2-Inch wg or Higher**:
 - 1) Test representative duct sections totaling no less than **50 percent** of total installed duct area for each designated pressure class.
 - c. Outdoor Air Ducts with a Pressure Class of **2-Inch wg or Higher**:
 - 1) Test representative duct sections totaling no less than **50 percent** of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to Vacuum Test in NADCA ACR, Assessment, Cleaning and Restoration of HVAC Systems.
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 START UP

A. Air Balance: Comply with requirements as specified.

3.9 DUCT SCHEDULE

- A. Supply Ducts:
 - 1. Ducts Connected to Constant-Volume Units, VRF Outside Air Units and RTUs:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- B. Return Ducts:

1.

- Ducts Connected to Constant-Volume Units, VRF Outside Air Units and RTUs:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- C. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - Ducts Connected to Constant-Volume Units, VRF Outside Air Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- E. Duct Liner:

1.

- 1. Supply Diffuser Plenums: Fibrous glass, Type I, 1 inch thick.
- 2. Return- Plenums: Fibrous glass, Type I, 1 inch thick.
- 3. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

END OF SECTION 23 31 13

Section 23 33 00 - Air Duct Accessories

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Motorized dampers.
 - 3. Spin Collars.
 - 4. Fire dampers.
 - 5. Ceiling Radiation Dampers.
 - 6. Smoke Dampers.
 - 7. Combination Fire and Smoke Dampers.
 - 8. Flange connectors.
 - 9. Turning vanes.
 - 10. Duct-mounted access doors.
 - 11. Flexible connectors.
 - 12. Flexible ducts.
 - 13. Duct accessory hardware.
 - 14. Outside Air Intake Hoods, roof mounted.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, Installation of Air Conditioning and Ventilating Systems, and with NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- B. Comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

- 1. Galvanized Coating Designation: G90.
- 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

- A. Low-Leakage, Steel, Manual Volume Dampers:
 - 1. Manufacturers:
 - a. Greenheck.
 - b. Dace Mfg.
 - c. Nailor Industries Inc.
 - d. Pottorff.
 - e. Ruskin Company.
 - 2. Comply with AMCA 500-D testing for damper rating.
 - 3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 4. Suitable for horizontal or vertical applications.
 - 5. Frames:
 - a. Hat Channel shaped.
 - b. 0.031-inch- thick, galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 6. Blades:
 - a. Multiple blade.
 - b. Opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.031 inch thick.
 - Blade Axles: Galvanized steel.
 - 8. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 9. Blade Seals: Neoprene.
 - 10. amb Seals: Stainless Steel.
 - 11. Tie Bars and Brackets: Galvanized steel.
 - 12. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

B. ackshaft:

7.

- 1. Size: 0.5-inch diameter.
- 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
- 3. Length and Number of Mountings: As required to connect linkage of each damper in multipledamper assembly.
- C. Damper Hardware:
 - 1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - 2. Include center hole to suit damper operating-rod size.
 - 3. Include elevated platform for insulated duct mounting.

2.4 MOTORIZED DAMPERS

- A. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- B. Manufacturers:
 - 1. Greenheck.
 - 2. Flex-Tek Group.
 - 3. Nailor Industries Inc.
 - 4. Pottorff.
 - 5. Ruskin Company.
- C. For Round Duct Type, Mechanical Contractor shall furnish and install motorized dampers at outdoor intakes as indicated on mechanical and architectural drawings. Damper shall be parallel blade motorized type equivalent to Ruskin CDRS25, Greenheck Model VCDR-53, Arrow Series 250SRD or equal. Motorized dampers shall be operated by 120/1/60 electric actuator as indicated on plans. Provide Interlock with respective air handling unit. Interlock with respective air handling unit shall be low voltage. Damper shall be complete with outboard support bearing, blade and jamb seals. Dampers shall be low leakage type.
- D. For Rectangular Duct Type, Mechanical Contractor shall furnish and install motorized dampers at outdoor intakes as indicated on mechanical and architectural drawings. Damper shall be parallel blade motorized type equivalent to Ruskin CD36/PB, Arrow Series 1770, Greenheck Model VCD-23 or equal. Motorized dampers shall be operated by 120/1/60 electric actuator as indicated on plans. Provide Interlock with respective air handling unit. Interlock with respective air handling unit shall be low voltage. Damper shall be complete with outboard support bearing, blade and jamb seals. Dampers shall be low leakage type.
- E. Frames:
 - 1. Hat shaped.
 - 2. 0.064-inch- thick, galvanized sheet steel.
 - 3. Mitered and welded corners.
- F. Blades:
 - 1. Multiple blade with maximum blade width of 6 inches.
 - 2. Opposed-blade design.
 - 3. Galvanized-steel.
 - 4. 0.064 inch thick single skin.
 - 5. Blade Edging: Closed-cell neoprene.
 - 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- G. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- H. Bearings:
 - 1. Molded synthetic.
 - 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 3. Thrust bearings at each end of every blade.

2.5 SPIN COLLARS

A. All round take-offs to round branch duct shall be made with factory fabricated spin-type collar fittings with balancing damper and constructed of minimum 26 ga galvanized steel. The damper shall have a raised 2" handle with a high quality locking quadrant. A 3/8" continuous rod with "U" bolts connects the damper to the rod. Nylon end bearing are required where the rod penetrates the spin collar barrel. These spin-collars shall be as manufactured by Flexmaster Model FLD-B03, Dace #26ga MSD-C03 or approved equal.

2.6 HIGH EFFICIENCY TAPS

A. All round connections to rectangular main ducts located upstream of VAV terminals shall be made with factory fabricated 45 degree low loss entry "shoe" tap fittings constructed of minimum 24 ga galvanized steel. These low loss fittings shall be as manufactured by Flexmaster Model STO, Dace #24ga STO or approved equal.

2.7 FIRE DAMPERS

A. The contractor shall furnish and install UL555 rated 1-1/2 hour fire dampers at the locations indicated on the drawings in new ducts and sound attenuators. The contractor shall provide dampers with sleeves and angle frames necessary to comply with the manufacturer's UL installation requirements. Dampers for vertical or horizontal air flow shall be provided as required.

B. Manufacturers:

- 1. Greenheck.
- 2. Flex-Tek Group.
- 3. Nailor Industries Inc.
- 4. Pottorff.
- 5. Ruskin Company.
- C. Fire damper shall be 100 free area and installed in wall and floor openings utilizing steel sleeves, angles, other materials and practice required to provide an installation equivalent to that utilized by the manufacturer when dampers are tested by UL555. Installation shall be in accordance with the damper manufacturer's instructions.
- D. Fire damper for rectangular ductwork and transfer openings shall be Ruskin type DIBD-B, Greenheck Model DFD-150-B (Basis of Design).
- E. Fire dampers for round ductwork shall be Ruskin Model DIBD-CR, Greenheck DFD-150-CR (Basis of Design).
- F. All fire dampers shall be installed per N.F.P.A. and U.L. requirements. Install U.L. approved sealant around the perimeter of the angle iron support at the sleeve and the wall in accordance with U. L. recommendations.
- G. All fire dampers shall meet the latest Class 1 leakage requirements.

2.8 CEILING RADIATION DAMPERS

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1. <u>Nailor Industries Inc</u>.

2. <u>Pottorff</u>.

3. <u>Ruskin Company</u>.

- B. General Requirements:
 - 1. Labeled according to UL 555C by an NRTL.
 - 2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's Fire Resistance Directory.
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.
- E. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.
- F. Fire Rating: 1 hours.

2.9 SMO E DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Pottorff.
 - 3. Ruskin Company.
- C. <u>http://www.specagent.com/Lookup ulid 3450</u>General Requirements: Label according to UL 555S by an NRTL.
- D. Smoke Detector: Integral, factory wired for single-point connection.
- E. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded corners.
- F. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- (1.6-mm) thick, galvanized sheet steel.
- G. Leakage: Class I.
- H. Rated pressure and velocity to exceed design airflow conditions.
- I. Mounting Sleeve: Factory-installed, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- . Damper Motors: two-position action.
- . Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 Common Motor Requirements for HVAC Equipment.
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 Direct Digital Control (DDC) System for HVAC.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for

running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).

- 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
- 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
- 7. Electrical Connection: 115 V, single phase, 60 Hz.
- L. Accessories:
 - 1. Auxiliary switches for signaling fan control or position indication.
 - 2. Test and reset switches, damper mounted.

2.10 COMBINATION FIRE AND SMO E DAMPERS

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1. <u>Greenheck Fan Corporation</u>.
 - 2. <u>Pottorff</u>.
 - 3. <u>Ruskin Company</u>.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded interlocking, gusseted corners.
- F. Heat-Responsive Device: Resettable, 165 deg F (74 deg C) rated, fire-closure device.
- G. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.
- H. Smoke Detector: Integral, factory wired for single-point connection.
- I. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel.
- . Leakage: Class I.
- . Rated pressure and velocity to exceed design airflow conditions.
- L. Mounting Sleeve: Factory-installed, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- M. Master control panel for use in dynamic smoke-management systems.
- N. Damper Motors: two-position action.
- O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 Common Motor Requirements for HVAC Equipment.

- 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 Direct Digital Control (DDC) System for HVAC.
- 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
- 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
- 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
- 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
- 7. Electrical Connection: 115 V, single phase, 60 Hz.
- P. Accessories:
 - 1. Auxiliary switches for signaling fan control or position indication.
 - 2. Test and reset switches, damper mounted.

2.11 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's HVAC Duct Construction Standards Metal and Flexible ; Figures 4-3, Vanes and Vane Runners, and 4-4, Vane Support in Elbows.
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.12 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible ; Figures 7-2, Duct Access Doors and Panels, and 7-3, Access Doors - Round Duct.
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
- c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.
- d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.13 DUCT ACCESS PANEL ASSEMBLIES

- A. Labeled according to UL 1978 by an NRTL.
- B. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- E. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.14 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.15 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Thermaflex Model M- E
 - 2. Flexmaster 1M
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1. (R6)
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
 - 2. Non-Clamp Connectors: Liquid adhesive plus tape.

2.16 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.17 OUTSIDE AIR INTA E HOODS (ROOF MOUNTED)

- A. Furnish and install intake hoods where indicated on Plans. Intake hood shall be Shipman Model SRV-1, Greenheck Model FGI/FGR, Acme Skymaster or prior approved equivalent.
- B. Each hood shall be of all extruded aluminum construction. Base and throat shall have continuous welded mitered corners. Hood and extrude structural members shall utilize stainless steel fasteners. Each hood shall have a full 360 degree perimeter opening for air flow. Hoods shall be designed to withstand 100 mph winds. Hoods shall be furnished with hinges to swing open for access to dampers. Each hood shall be furnished with mesh insect screens and factory fabricated roof curb.
- C. Intake hoods shall have a 2-to-1 ratio of hood perimeter opening to throat area to provide an inlet velocity at the hood opening not to exceed 650 feet per minute.
- D. Hood shall be provided with a minimum of a 14" high roof curb.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's HVAC Duct Construction Standards - Metal and Flexible for metal ducts and in NAIMA AH116, Fibrous Glass Duct Construction Standards, for fibrous-glass ducts.

- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Upstream from duct filters.
 - 2. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 4. At each change in direction and at maximum 50-foot spacing.
 - 5. Control devices requiring inspection.
 - 6. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- . Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- . Label access doors according to Section 230553 Identification for HVAC Piping and Equipment to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands.
- P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

Section 23 34 23 - HVAC Power Ventilators

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Centrifugal ceiling fans.
 - 2. Inline exhaust fans.

1.3 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CEILING MOUNTED FANS

- A. Manufacturers:
 - 1. Cook.
 - 2. Greenheck.
 - 3. ACME
 - 4. Pen-Barry
 - 5. Twin City
- B. All exhaust fans shall be equipped with bird screen, automatic back-draft dampers, solid state speed controller (direct drive) and integral disconnect switch unless noted otherwise. Fan motors shall be of the 40 deg C ambient temperature rise type and shall be suitable for continuous duty operation.
- C. Direct drive fans shall be complete with solid state speed control switch mounted on unit for balancing. Interlock with remote on/off switch.
- D. Housing: Steel, lined with acoustical insulation.
- E. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- F. Grille: White ceiling mounted metal grille. The grille shall be removable to provide service access to fan, motor, etc.
- G. Electrical Requirements: unction box for electrical connection on housing and receptacle for motor plugin.

2.2 INLINE EXHAUST FANS

- A. Manufacturers:
 - 1. Cook.
 - 2. Greenheck.
 - 3. ACME
 - 4. Pen-Barry
 - 5. Twin City
- B. All exhaust fans shall be equipped with bird screen, automatic back-draft dampers, solid state speed controller (direct drive) and integral disconnect switch unless noted otherwise. Fan motors shall be of the 40 deg C ambient temperature rise type and shall be suitable for continuous duty operation.
- C. Direct drive fans shall be complete with solid state speed control switch mounted on unit for balancing. Interlock with remote on/off switch.

- D. Housing: Steel.
- E. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- F. Electrical Requirements: unction box for electrical connection on housing and receptacle for motor plugin.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 Common Motor Requirements for HVAC Equipment.
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data. Factory test fans according to AMCA 300, Reverberant Room Method for Sound Testing of Fans. Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating. Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Install units with clearances for service and maintenance.
- C. Label units according to requirements specified.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment.

3.3 AD USTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

END OF SECTION 23 34 23

Section 23 37 13 - Diffusers, Registers, Grilles, and Louvers

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Louvered face diffuser.
 - 3. Fixed face registers and grilles.
 - 4. Louvers.
- B. Related Sections:
 - 1. Section 233300 Air Duct Accessories for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

1.

2.1 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers:
 - Manufacturers:
 - a. Titus.
 - b. Price Industries.
 - c. Nailor Industries.
 - d. Metalaire, Inc.
 - 2. Devices shall be specifically designed for variable-air-volume flows.
 - 3. Material: Aluminum.
 - 4. Finish: Baked enamel, white.
 - 5. Face Size: 24 by 24 inches.
 - 6. Face Style: Three cone.
 - 7. Mounting: T-bar.
 - 8. Pattern: Fixed.
- B. Louver Face Diffuser:

- 1. Material: Aluminum.
- 2. Finish: Baked enamel, white.
- 3. Face Size: See schedule on Drawings..
- 4. Mounting: Surface with beveled frame.
- 5. Pattern: Four-way core style.
- 6. Dampers: Radial opposed blade.
- 7. Accessories:
 - a. Square to round neck adaptor.

2.2 REGISTERS AND GRILLES

A. Fixed Face Register:

1.

- Manufacturers:
 - a. Titus.
 - b. Price Industries.
 - c. Nailor Industries.
 - d. Metalaire, Inc.
- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white.
- 4. Core Construction: Integral.
- 5. Frame: 1 inch wide.
- 6. Mounting: Lay in.

2.3 LOUVERS

A. Provide louvers as scheduled in Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 AD USTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

Section 23 51 23 - Gas Vents

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. Listed double-wall vents.
- B. Related Requirements:
 - 1. Section 235113.11 Draft Control Fans for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
 - 2. Section 235113.16 Vent Dampers for motorized and barometric dampers.
 - 3. Section 235116 Fabricated Breechings and Accessories for listed, refractory-lined metal breechings and field-fabricated metal breechings.
 - 4. Section 235133 Insulated Sectional Chimneys for listed chimney liners; listed building-heatingappliance chimneys; listed, refractory-lined metal chimneys; and field-fabricated chimneys.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.
- B. Shop Drawings: For vents.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly of hangers and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Sample Warranty: For special warranty.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, Structural Welding Code Steel, for hangers and supports.
 - 2. AWS D9.1/D9.1M, Sheet Metal Welding Code, for shop and field welding of joints and seams in vents.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 LISTED TYPE B AND BW VENTS

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1. American Metal Products.
 - 2. <u>Industrial Chimney Company</u>.
 - 3. <u>Metal-Fab, Inc</u>.
 - 4. <u>Security Chimneys International</u>.
 - 5. <u>Tru-Flex Metal Hose Corp.</u>
- B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.
- D. Inner Shell: ASTM A 666, Type 430 stainless steel.
- E. Outer acket: Aluminized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination: Antibackdraft.
 - 5. Termination: Roof.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Listed Type B and BW Vents: Vents for certified gas appliances.
- B. Listed Type L Vent: Vents for low-heat appliances.
- C. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF LISTED VENTS

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 Roof Accessories.
- B. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- C. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- E. Lap joints in direction of flow.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 23 51 23

Section 23 55 33 - Gas-Fired Unit Heaters

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gas-fired unit heaters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of gas-fired unit heater.
 - 1. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings: For gas-fired unit heaters. Include plans, elevations, sections, and attachment details.
 - 1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired unit heaters, as well as procedures and diagrams.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which equipment will be attached.
 - 2. Items penetrating roof and the following:
 - a. Vent and gas piping rough-ins and connections.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One for each belt-driven fan size.

1.7 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - Heating, Ventilating, and Air-Conditioning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1. <u>Trane.</u>
 - 2. <u>Modine Manufacturing Company</u>.
 - 3. <u>REZNOR; Thomas</u> Betts Corporation, a member of ABB Group.
 - 4. <u>Sterling HVAC Products; a Mestek company</u>.
 - 5. Raywall

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Capacities shall be as indicated in the Mechanical Schedules.

2.3 MANUFACTURED UNITS

- A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
- B. Gas Type: NATURAL GAS.
 - 1. Design burner for natural gas having characteristics same as those of gas available at Project site.
- C. Type of Venting: Indoor, separated combustion, power vented.
- D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
 - 1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
 - 2. Discharge Louvers: Independently adjustable, horizontal blades.
 - 3. Discharge Nozzle: Discharge at 25 to 65 degrees from horizontal.

E. Accessories:

- 1. Four-point suspension kit.
- 2. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
- 3. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.
- F. Heat Exchanger: Aluminized steel.
- G. Burner Material: Aluminized steel with stainless-steel inserts.
- H. Propeller Unit Fan:
 - 1. Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
 - 2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

I. Motors:

- 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 Common Motor Requirements for HVAC Equipment.
- 2. Efficiency: Premium efficient.
- Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 - 1. Gas Control Valve: Single stage.
 - 2. Ignition: Electronically controlled electric spark with flame sensor.
 - 3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
 - 4. Vent Flow Verification: Differential pressure switch to verify open vent.
 - 5. Control transformer.
 - 6. High Limit: Thermal switch or fuse to stop burner.
 - 7. Wall-Mounted Thermostat:
 - a. Single stage.
 - b. Fan on-off-automatic switch.
 - c. 24-V ac.
 - d. 50 to 90 deg F operating range.
- Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.
- C. Gas Piping: Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

3.4 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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 AD USTING

- A. Adjust initial temperature and humidity set points.
- B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION 23 55 33

Section 23 81 20 – Split-System Air-Conditioners

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Two set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.

3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, Safety Standard for Refrigeration Systems.
 - ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 Outdoor Air Quality, Section 5 - Systems and Equipment, Section 6 - Procedures, and Section 7 -Construction and System Start-up.
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 Cast-in-Place Concrete.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: Five year(s) from date of Substantial Completion.
 - c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier.
 - 2. Trane.
 - 3. York.
 - 4. Lennox.

2.2 AIR HANDLING UNITS (5 TONS OR LESS)

- A. Evaporator-Fan Components:
 - 1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 - 2. Insulation: Faced, glass-fiber duct liner.
 - 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 - 4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
 - 5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
 - 6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 Common Motor Requirements for HVAC Equipment.
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
 - 7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 8. Filters: 1" Permanent, cleanable.
 - 9. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 inches deep.
 - b. Single-wall, stainless-steel sheet.
 - c. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
 - 1) Minimum Connection Size: NPS 1.
 - e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 CONDENSING UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
 - 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
- 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
- 4. Fan: Aluminum-propeller type, directly connected to motor.
- 5. Motor: Permanently lubricated, with integral thermal-overload protection.
- 6. Low Ambient it: Permits operation down to 45 deg F.
- 7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230923 Direct Digital Control (DDC) System for HVAC and Section 230993.11 Sequence of Operations for HVAC DDC.
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- D. Automatic-reset timer to prevent rapid cycling of compressor.
- E. Refrigerant Line its: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- F. Drain Hose: For condensate.
- G. Additional Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable-frequency-drive operation.
 - 3. Monitor economizer cycle.
 - 4. Monitor cooling load.
 - 5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 Roof Accessories. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 Cast-in-Place Concrete.
 - 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
 - 3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 Vibration and Seismic Controls for HVAC.
 - 4. Comply with requirements for vibration isolation devices specified in Section 230548.13 Vibration Controls for HVAC.
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Water Coil Connections: Comply with requirements specified in Section 232113 Hydronic Piping and Section 232116 Hydronic Piping Specialties. Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
 - 2. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 232113 Hydronic Piping and Section 232116 Hydronic Piping Specialties. Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113 Metal Ducts. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system airconditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 Air Duct Accessories.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 20

Section 23 90 20 – Temperature Controls

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. Electric temperature control system by the air conditioning equipment manufacturer, to be installed by the mechanical contractor.
 - 2. Thermostats.
 - 3. Thermostat Covers.
 - 4. Float Switches.
 - 5. Motorized Dampers.
 - 6. Exhaust Fans.
 - 7. Smoke Detectors.
 - 8. Control Wiring.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. General Requirements.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

PART 2 - PRODUCTS

2.1 THERMOSTAT

A. Provide <u>fully automatic</u> programmable (7 day) room type thermostat as indicated on Plans to cycle compressor on cooling cycle, and compressor and/or electric strips in stages on heating cycle as required to maintain space conditions. Unit shall be wired for constant or automatic fan operation and shall be electrically interlocked such that the compressor may not run nor the electric strip heaters be energized unless the evaporator fan is operating. Thermostat shall be complete with fan Auto-On switch and system Auto-Heat-Off-Cool switch. Thermostats shall be mounted to meet latest A.D.A. requirements.

2.2 THERMOSTAT COVER

A. Provide heavy duty plastic, key-locked thermostat covers on all thermostats. One key shall be capable of opening all covers. Confirm with architect prior to installing.

2.3 FLOAT SWITCH

A. Provide float switch to emergency drain pan of each AHU. Switch shall be interlocked with AHU to deenergize the unit when the water level in the pan rises above a set level. Float switch shall meet UL 508 requirements.

2.4 CARBON OXIDE / NITROGEN DIOXIDE SENSOR

A. Interlock Carbon Oxide / Nitrogen Dioxide sensor with starter for exhaust fan "EF-3". Fan shall turn on when the Cardon Oxide and/or Nitrogen Dioxide sensor is in alarm. Fan shall turn off when sensor is not in alarm. Provide all necessary wiring, relays, switches, transformers, etc. as required. Refer to specification section 233423 for additional information on the Nitrogen Dioxide sensor.

2.5 END SWITCH O.A. INTA E LOUVERS (Louver Type L-2)

A. Provide an end switch and Interlock with starter for exhaust fan "EF-5". Fan shall turn on when the motorized damper is fully open. Provide all necessary wiring, relays, switches, transformers, etc. as

2.6 MOTORIZED DAMPERS

- A. O.A. motorized dampers shall be interlocked with their respective unit in respective mechanical room to open when the A/C unit's compressor or heating strip is energized (On), and shall close when the unit's compressor and heating strip is de-energized (Off). Provide all necessary relays, switches, transformers, etc. as required.
- B. Motorized dampers shall be furnished and set in place by contractor installing the ductwork.
- C. Damper actuators shall be 120/1/60 electric actuators specifically selected for damper manufacturer's requirements. Controls contractor shall furnish and install actuators. Coordinate all work with contractor installing dampers

2.7 EXHAUST FAN SEQUENCE OF OPERATION

- A. EXHAUST FAN # "EF-5"
 - 1. Provide starter on wall as indicated on Plans.
- B. EXHAUST FAN # "EF-1", "EF-2", "EF-3", "EF-4" and "EF-6"
 - 1. (Restrooms) Provide interlock wiring with lights. Fan shall be on when lights are on and off when lights are off. Solid state speed control switch mounted in fan housing shall be used for balancing air flow.

2.8 SMO E DETECTOR

- A. The Mechanical Contractor shall furnish and install a smoke detector in the supply duct and return duct of all air handlers delivering 2000 C.F.M. or above. Interlock the smoke detector to de-energize fan on actuation of detector.
- B. Smoke detectors shall have auxiliary contacts for interlock with the fire alarm system. Coordinate installation and selection of smoke detectors. Entire installation shall meet UL requirements for interlock with building fire alarm and security system.
- C. Provide remote audible and visual alarm unit with remote reset (one per AHU with smoke detector) in accordance with latest N.F.P.A. 90A requirements.
- D. Dual-chamber, ionization smoke detectors: The combination detector head, and twist-lock base shall be UL listed compatible with a UL listed fire alarm panel.
- E. The smoke detector shall have a flashing status indication LED or visual supervision. When the detector is actuated, the flashing LED shall latch on steady and at full brilliance. The detector may be reset by activating the control panel remote reset switch.
- F. The sensitivity of the detector shall be monitored without removal of the detector head. Metering set points shall be accessible on the exterior of the detector head. Field adjustment the sensitivity shall be possible when conditions require a change.
- G. It shall be possible to perform a functional test of the detector without the need of generating smoke. The test method must simulate effects of products of combustion in the chamber to ensure testing of all detector circuits.
- H. Voltage and RF transient suppression techniques shall be employed to minimize false alarm potential. A gated alarm output shall be used for additional detector stability.
- I. Auxiliary SPDT relays and/or remote LED alarm indicators shall be installed as required.
- . Duct mounted smoke detectors shall shut down the associated air handling unit fan motor and fire/smoke damper. This contractor shall provide all equipment and labor as required to accomplish same.
- . Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.9 CONTROL WIRING

- A. All wiring required in the control systems, including electrical connections for the thermostats, firestats, smoke detectors, exhaust fans and all interlocking motor control wiring shall be furnished and installed by Mechanical Contractor.
- B. All wiring shall be in conduit and in accordance with the National Electrical Code (N.E.C.).
- C. All control wiring located outdoors shall be installed in rigid or intermediate metal conduit.
- D. All control wiring located indoors where an accessible ceiling is not available shall be installed in E.M.T. conduit.
- E. All control wiring located above accessible ceilings shall be N.E.C. approved cable. All control wiring located above accessible ceilings used as air plenums shall be N.E.C. approved plenum cable .

F. All conductors shall be copper. Conductors used for power circuits shall be #12 TW minimum. Conductors used for control circuits shall be #18 TW (single strand) minimum. Conductors used for sensor circuits shall be #18 TW (single strand) minimum. Control wiring for DX equipment thermostats shall be 10 conductor cables.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
 - 1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 - 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

END OF SECTION 23 90 20

Section 26 05 00 – Common Work Results for Electrical

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Electricity-metering components.
 - 3. Concrete equipment bases.
 - 4. Touchup painting.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

1.3 QUALITY ASSURANCE

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

1.4 COORDINATION

- 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 installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections with buildings and grounds.
- D. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.



- E. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.
- F. Coordinate connecting to all equipment with equipment provider. This includes mechanical, plumbing, owner provided and contractor provided equipment. Contractor to refer to equipment installation documents prior to any rough-in.
- G. Contractor to coordinate with door hardware provider, architect and owner prior to installation of any devices associated with doors to verify door operational requirement, placement of proximity readers, motion sensors, door switches, fire alarm control, magnetic locks, hold open devices, etc..
- H. Contractor to coordinate with architectural millwork shop drawings prior to rough-in for locations of under counter lighting to be installed in and around millwork. No receptacles shall be installed in an enclosed cabinet unless noted on the drawings. Outlets for refrigerators, microwaves, etc. shall be installed in the space identified on the millwork shop drawings.
- I. Contractor shall not penetrate any stair wall assemble with conduit, boxes, cabling and the like, except for items that serve the stairwell.
- . The contractor shall label the main service disconnecting means with the maximum available fault current shall be listed on the device to meet the requirements of NFPA 70:110.24. The labeling shall be engraved plastic. The maximum available fault current shall be obtained from the electrical utility for the secondary side of the utility transformer.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.
- D. 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.
- E. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- F. Expansion Anchors: Carbon-steel wedge or sleeve type.
- G. Toggle Bolts: All-steel springhead type.
- H. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY CONTRACTOR

A. Meter: Contractor shall provide metering per the local utility. Contractor shall provide all necessary enclosures, meter cans, etc. per the local utility requirements including any fees associated with the service.

2.3 CONCRETE BASES

A. Concrete: 3000-psi (20.7-MPa), 28-day compressive strength as specified

2.4 TOUCH-UP PAINT

- A. For 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. 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 (90-kg) 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 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- 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 (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- . Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheetmetal 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 (610 mm) from the box.
- . 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.
- L. 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.
- M. 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.
 - 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. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
 - 6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply 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 percent of its proof-test load.

3.4 FIRESTOPPING AND FIRE RATED WALLS/CEILINGS/FLOORS

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified.
- 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.

3.5 CONCRETE BASES

A. Provide a concrete base for all floor mounted equipment. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Section Cast-in-Place Concrete.

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 REFINISHING AND TOUCH-UP PAINTING

- A. Refinish and touch up paint.
 - 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 touchup coating recommended by manufacturer.

3.8 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 26 05 00

Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
- B. Related Sections include the following:
 - 1. Section Medium-Voltage Cables for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70- Latest edition or edition enforced by state and local code authority.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Refer to Part 3 Conductor and Insulation Applications Article for insulation type, cable construction, and ratings.
- B. Conductor Material: Copper; stranded conductor or solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- C. Conductor Insulation Types: Type THHN-THWN.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Fire Alarm Cabling: Plenum rated in plenum areas, exposed above accessible ceilings and in conduit when concealed in finished walls, unaccessible ceilings. Secured per NFPA 70-760.
- I. Low Voltage Cabling: Plenum rated in plenum areas, exposed above accessible ceilings and in conduit when concealed in finished walls, unaccessible ceilings. Secured per NFPA 70-760.
- . Single Phase Circuits: Provide a dedicated neutral. Sharing of neutrals is not allowed.

3.2 INSTALLATION

- A. Conceal cables in conduit in finished walls, unaccessible ceilings, and floors.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Support cables according to Section Basic Electrical Materials and Methods.
- E. Identify and color-code conductors and cables according to Section Electrical Identification.
- F. Use #10 AWG conductors for 20 amperage 120 circuits when the circuit conductors are longer than 75 feet. Use #10 AWG conductors for 20 amperage 277 circuits when the circuit conductors are longer than 200 feet.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

1. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

END OF SECTION 26 05 19
Section 26 05 26 – Grounding and Bonding for Electrical Systems

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.
 - 1. Underground grounding.
 - 2. Common ground bonding with lightning protection system.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding umper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding umper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches by 24" minimum in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by10 feet (19 mm by 3 m) in diameter.

2.4 GROUND ACCESS WELLS

A. Molded high density polyethylene well with 9" diameter twist-lock cover and locking bolt. Two knock-outs (mouse holes) for routing conductor to inside. Harger #GAW910 or equal.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits
- D. Pad-Mounted Transformers and Switches: The following is a minimum if the utility company does not have requirements, otherwise meet the utility company requirements. Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 - 10. X-ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
 - 3. Install ground access well with cover for each ground rod (mounted flush with finished grade).

- D. Bonding Straps and umpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building as indicated on detail or drawings.
 - 1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches from building foundation.
- I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity 500 kVA and less: 10 ohms.
 - 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Manhole Grounds: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

Section 26 05 29 – Hangers and Supports for Electrical Systems

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 26 Section Vibration and Seismic Controls for Electrical Systems for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.

- 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.
- 1.6 QUALITY ASSURANCE
 - A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code Steel.
 - B. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section Roof Accessories.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: a. Allied Tube Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs

shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. 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) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) M T Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) M T Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section Metal Fabrications for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps / single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC RMC EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section Metal Fabrications for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section Cast-in-Place Concrete.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

Section 26 05 33 – Raceways and Boxes for Electrical Systems

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Refer to architectural for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 2. Basic Electrical Materials and Methods for supports, anchors, and identification products.
 - 3. Wiring Devices for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, floor boxes, and cabinets.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70-Latest edition or edition enforced by state and local code authority.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 METAL WIREWAYS

- A. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R.
- B. 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.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.2 NONMETALLIC WIREWAYS

- A. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- B. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.3 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and two coats of paint. Color by Architect.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.4 BOXES, ENCLOSURES, AND CABINETS

Floor Boxes: Cast metal, fully adjustable, rectangular with four separate wiring compartments for power outlets, voice and data outlets, and/or AV devices as indicated on the drawing. Wiremold RFB4 Series,
T B 665 Series or approved equal. Covers shall be UL Listed to U.S. and Canadian safety standards for

tile, carpet, wood, bare concrete and terrazzo floors. Covers shall be selected by the architect and shall be of Nickel, Brass, Black, Gray or Bronze.

- B. Poke Thru Floor Boxes: Two hour rated poke thru floor unit with capabilities of two duplex power receptacles, data and AV devices. Provide power, data and phone outlets indicated on drawing. Wiremold Evolution Series 6AT or prior approved equal. Covers shall be selected by the architect and shall be of Nickel, Brass, Black, Gray or Bronze. Poke thru floor boxes are to be utilized on upper floors unless noted otherwise. There must be accessibility in the space below the poke thru box.
- C. Small Sheet Metal Pull and unction Boxes: NEMA OS 1.
- D. Cast-Metal Pull and unction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- F. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. ey latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.
- G. Exterior Outlet Lock Box: Cast aluminum with self closing door withlock. All units shlal be keyed alike. 16 gauge steel housing. Unit for Interior and Exterior installation. Cole: TL-310 or equivalent.
- H. In grade enclosures, boxes and covers are required to conform to all test provisions of the most current ANSI/SCTE 77 "Specification For Underground Enclosure Integrity" for Tier 22 applications. When multiple "Tiers" are specified the boxes must physically accommodate and structurally support compatible covers while possessing the highest Tier rating. All covers are required to have the Tier level rating embossed on the surface. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box cover) are manufactured using matched surface tooling. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal. Cover to labeled per use of box, ie "Electrical, Communications, etc". Communications pull boxes shall be a minimum of 24" w x 36" l x 36 " d.

2.5 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

2.6 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Aluminum Rigid Conduit: ANSI C80.5.
- C. IMC: ANSI C80.6.
- D. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- E. Plastic Coated IMC and Fittings: NEMA RN 1.

- F. EMT and Fittings: ANSI C 80.3.
- G. EMT and Fittings: ANSI C80.3.
- H. FMC: Aluminum
- I. LFMC: Flexible steel conduit with PVC jacket.
- Fittings: NEMA FB 1; compatible with conduit and tubing materials.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- Α. Outdoors:
 - 1. Exposed: Rigid steel or IMC.
 - Concealed: Rigid steel or IMC. 2.
 - 3. Underground, Single Run: RNC.
 - 4. Underground, Grouped: RNC.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 4.
- B. Indoors:
 - 1. Exposed: EMT in non finished areas. Surface metal raceway in existing finished unaccessible areas unless noted otherwise.
 - 2. Concealed: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 - Damp or Wet Locations above Ground: Rigid steel conduit. 4. 5.
 - Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - Damp or Wet Locations: NEMA 250, Type 4, stainless steel. a.
- C. Minimum Raceway Size: 3/4-inch trade size (DN 21) below grade and ½ inch trade size above grade.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
- E. Contractor to provide metal raceway in Patient Care Areas per 517.13. Raceway shall be installed as a redundant ground. Raceway shall be a considered a ground.

3.2 **INSTALLATION**

- eep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Α. Install horizontal raceway runs above water and steam piping.
- Β. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Basic Electrical Materials and Methods.
- D. Install temporary closures to prevent foreign matter from entering raceways.

- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. eep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover. Conduits larger than 1" shall not be installed in the slab.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
 - oin raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
 - . Tighten set screws of threadless fittings with suitable tools.
- L. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- N. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- O. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- P. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

- Q. Set floor boxes level and flush with finished floor surface.
- R. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 **PROTECTION**

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 05 33

Section 26 05 53 – Identification for Electrical Systems

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for conductors and communication and control cable.
 - 2. Warning labels and signs.
 - 3. Instruction signs.
 - 4. Equipment identification labels.
 - 5. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- 1.4 QUALITY ASSURANCE
 - A. Comply with ANSI A13.1 and ANSI C2.
 - B. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes and standards. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: DANGER ELECTRICAL SHOC HAZARD EQUIPMENT HAS MULTIPLE POWER SOURCES.
 - 2. Workspace Clearance Warning: WARNING OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE EPT CLEAR FOR 36 INCHES.

2.3 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb, minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.

- B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
 - 1. Exterior Concrete Unit Masonry:
 - Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Exterior semigloss acrylic enamel.
 - 2. Exterior Ferrous Metal:

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- Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior ferrous-metal primer.
 - 2) Finish Coats: Exterior semigloss alkyd enamel.
- 3. Exterior Zinc-Coated Metal (except Raceways):
 - 1) Primer: Exterior zinc-coated metal primer.
 - 2) Finish Coats: Exterior semigloss alkyd enamel.
- 4. Interior Ferrous Metal:
 - Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- 5. Interior Zinc-Coated Metal (except Raceways):
 - Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
- B. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

- 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- E. Instruction Signs:
 - 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 - 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- F. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Emergency system boxes and enclosures.
 - f. Receptacles with panel and circuit numbers.
 - g. Disconnect switches.
 - h. Enclosed circuit breakers.
 - i. Power transfer equipment.
 - j. Contactors.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service feeder branch-circuit service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

END OF SECTION 26 05 53

Section 26 05 73 - Arc-Flash Hazard Analysis

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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See One-Line Diagram.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:

- 1. Arc-flash study input data, including completed computer program input data sheets.
- 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
- 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
 - 2. Operation and Maintenance Procedures: In addition to items specified in Section 01 78 23 Operation and Maintenance Data, provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arcflash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Double click here to find, evaluate, and insert list of manufacturers and products.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate mandatory, very desirable, and desirable features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in Power System Data Article.
- E. Short-Circuit Study Output Data: As specified in Short-Circuit Study Output Reports Paragraph in Short-Circuit Study Report Contents Article in Section 26 05 73.13 Short-Circuit Studies.
- F. Protective Device Coordination Study Report Contents: As specified in Coordination Study Report Contents Article in Section 26 05 73.16 Coordination Studies.
- G. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.

- f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Restricted approach boundary.
 - 6. Limited approach boundary.
 - 7. Working distance.
 - 8. Incident energy.
 - 9. Hazard risk category.
 - 10. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 26 05 53 Identification for Electrical Systems for self-adhesive equipment labels. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, WARNING, ARC-FLASH HAZARD, and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 - 4. Arc flash PPE category.
 - 5. Required minimum arc rating of PPE in Cal/cm squared.
 - 6. Available incident energy.
 - 7. Working distance.
 - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis or obtain results from another source.
 - 1. Short-Circuit Study Output: As specified in Short-Circuit Study Output Reports Paragraph in Short-Circuit Study Report Contents Article in Section 26 05 73.13 Short-Circuit Studies.
 - 2. Coordination Study Report Contents: As specified in Coordination Study Report Contents Article in Section 26 05 73.16 Coordination Studies.
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
 - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
 - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
 - 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arcflash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

- 1. Verify completeness of data supplied on one-line diagram on Drawings and under Preparatory Studies Paragraph in Arc-Flash Hazard Analysis Article. Call discrepancies to Architect's attention.
- 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
- 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance or available short circuit current at the service.
 - 3. Power sources and ties.
 - 4. Short-circuit current at each system bus (three phase and line to ground).
 - 5. Full-load current of all loads.
 - 6. Voltage level at each bus.
 - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
 - 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 - 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 - 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 - 12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
 - 13. Motor horsepower and NEMA MG 1 code letter designation.
 - 14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 - 15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 - 1. Motor-control center.
 - 2. Low-voltage switchboard.
 - 3. Switchgear.
 - 4. Medium-voltage switch.
 - 5. Medium voltage transformers

- 6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
- 7. Panelboard and safety switch over 250 V.
- 8. Applicable panelboard and safety switch under 250 V.
- 9. Control panel.
- 10. Generator
- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
 - 1. Indicate arc-flash energy.
 - 2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION 26 05 73

Section 26 09 23 – Lighting Control Devices

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Lighting contactors.
 - 5. Emergency shunt relays.
- B. Related Sections include the following:
 - 1. Division 26 Section Wiring Devices for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Layout of all devices on floor plan. Work to be done in electronic form such as AutoCAD. Manufacture shall provide a design to accommodate proper coverage throughout.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Color of all wall mounted devices of this section shall match color of devices and plates of the wiring device section.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 2. Intermatic, Inc.
 - 3. Leviton Mfg. Company Inc.
 - 4. Lightolier Controls; a Genlyte Company.
 - 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 6. Paragon Electric Co.; Invensys Climate Controls.
 - 7. Square D; Schneider Electric.
 - 8. TOR .
 - 9. Touch-Plate, Inc.
 - 10. Watt Stopper (The).
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
 - 1. Contact Configuration: DPDT.
 - 2. Contact Rating: 30-A inductive or resistive, 240-V ac.
 - 3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
 - 4. Programs: 2 channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.
 - 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
 - 6. Astronomic Time: All channels.
 - 7. Battery Backup: For schedules and time clock.
- C. Electromechanical-Dial Time Switches: Type complying with UL 917.
 - 1. Contact Configuration: DPDT.
 - 2. Contact Rating: 30-A inductive or resistive, 240-V ac.
 - 3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 - 4. Astronomic time dial.
 - 5. Eight-Day Program: Uniquely programmable for each weekday and holidays.

- 6. Skip-a-day mode.
- 7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. 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. Area Lighting Research, Inc.; Tyco Electronics.
 - 2. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 3. Intermatic, Inc.
 - 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 5. GreenGate.
 - 6. Paragon Electric Co.; Invensys Climate Controls.
 - 7. Square D; Schneider Electric.
 - 8. TOR .
 - 9. Touch-Plate, Inc.
 - 10. Watt Stopper (The).
- B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 - 2. Time Delay: 15-second minimum, to prevent false operation.
 - 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 - 4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-andswivel mounting accessories as required to direct sensor to the north sky exposure.
- C. Description: Solid state, with DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.
 - 1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
 - 2. Time Delay: 30-second minimum, to prevent false operation.
 - 3. Lightning Arrester: Air-gap type.
 - 4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.3 INDOOR OCCUPANCY SENSORS

- A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Lighting.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 4. GreenGate.
 - 5. Sensor Switch, Inc.
 - 6. Watt Stopper (The).

- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 - 6. Bypass Switch: Override the on function in case of sensor failure.
 - 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
 - 8. Wall mounted devices color shall match color selected for switches and receptacles. Refer to other sections in specifications.
 - 9. Meet Nema WD 7-2011 requirements.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
 - 1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 - 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
 - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
- F. System and Design Requirements:
 - 1. Products supplied shall be from a single manufacturer that has been continuously involved in manufacturing of occupancy sensors for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.
 - 2. All components shall be U.L. listed, offer a five (5) year warranty and meet all state and local applicable code requirements.
 - 3. Products shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1 .
 - 4. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
 - 5. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits
 - 6. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
 - 7. Meet Nema WD 7-2011 requirements.

2.4 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allen-Bradley/Rockwell Automation.
 - 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 - 3. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 4. GE Industrial Systems; Total Lighting Control.
 - 5. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 6. Hubbell Lighting.
 - 7. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 8. MicroLite Lighting Control Systems.
 - 9. Square D; Schneider Electric.
 - 10. TOR .
 - 11. Touch-Plate, Inc.
 - 12. Watt Stopper (The).
 - 13. Siemens
- B. Description: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

- 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
- 3. Enclosure: Comply with NEMA 250.
- 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section Low-Voltage Electrical Power Conductors and Cables.
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section Low-Voltage Electrical Power Conductors and Cables.
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section Low-Voltage Electrical Power Conductors and Cables.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. It shall be the contractor's responsibility to 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 ninety (90) to one hundred (100) percent 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 drawings indicate only the rooms which are to be provided with sensors. The contractor shall provide sensors as required to properly and completely cover the respective room.
- B. It is the contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.
- C. It is the contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.
- D. Contractor's work to include all labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein. Drawings may indicate the room in which occupancy sensor control is required. The contractor and manufacture shall provide a device to provide proper coverage of the area.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section Low-Voltage Electrical Power Conductors and Cables. Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section Identification for Electrical Systems.
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.
- C. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system.

3.6 AD USTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section Demonstration and Training.

END OF SECTION 26 09 23

Section 26 24 16 - Panelboards

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.

- 5. Short-circuit current rating of panelboards and overcurrent protective devices.
- 6. Include evidence of NRTL listing for series rating of installed devices.
- 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 8. Include wiring diagrams for power, signal, and control wiring.
- 9. ey interlock scheme drawing and sequence of operations.
- 10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 Operation and Maintenance Data, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. eys: Two spares for each type of panelboard cabinet lock.
 - 2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Architect's written permission.
 - 3. Comply with NFPA 70E.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48.16 Seismic Controls for Electrical Systems.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. itchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Height: 84 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- G. Incoming Mains:
 - 1. Location: Convertible between top and bottom.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
 - 6. Split Bus: Vertical buses divided into individual vertical sections.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

- 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
- 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
- 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- 8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
- NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 - 1. Percentage of Future Space Capacity: 20 percent.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
 - 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 - 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1. <u>Eaton</u>.
 - 2. <u>General Electric Company; GE Energy Management Electrical Distribution</u>.
 - 3. <u>Siemens Industry, Inc., Energy Management Division</u>.
 - 4. <u>Square D; by Schneider Electric</u>.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: As per schedule
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on electronic circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1. <u>Eaton</u>.
 - 2. <u>General Electric Company; GE Energy Management Electrical Distribution</u>.
 - 3. <u>Siemens Industry, Inc., Energy Management Division</u>.
 - 4. <u>Square D; by Schneider Electric</u>.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: As indicated on the schedules.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.
- F. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.
 - 1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
 - 1. <u>Eaton</u>.
 - 2. <u>General Electric Company; GE Energy Management Electrical Distribution</u>.
 - 3. <u>Siemens Industry, Inc., Energy Management Division</u>.
 - 4. <u>Square D; by Schneider Electric</u>.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, fieldadjustable trip setting.
 - 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:

- 1) Instantaneous trip.
- 2) Long- and short-time pickup levels.
- 3) Long and short time adjustments.
- 4) Ground-fault pickup level, time delay, and I squared T response.
- 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, R -5.
- 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
- 6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- 8. Subfeed Circuit Breakers: Vertically mounted.
- 9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 Electrical Power Monitoring and Control.
 - h. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - i. Auxiliary Contacts: Two, SPDT switches with a and b contacts; a contacts mimic circuit-breaker contacts and b contacts operate in reverse of circuit-breaker contacts.
 - j. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - k. ey Interlock it: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 1. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
- C. Fused Switch: NEMA S 1, Type HD; clips to accommodate specified fuses; lockable handle.
 - 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 26 28 13 Fuses.
 - 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.
 - b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover. Typed written.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
 - 1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 Cast-in-Place Concrete.

- 2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- 3. Comply with requirements for seismic control devices specified in Section 26 05 48.16 Seismic Controls for Electrical Systems.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 Seismic Controls for Electrical Systems.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
 - Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- . Install filler plates in unused spaces.
- L. 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.
- M. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- N. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 Identification for Electrical Systems.
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 Identification for Electrical Systems.
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 Identification for Electrical Systems.
- E. Install warning signs complying with requirements in Section 26 05 53 Identification for Electrical Systems identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 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. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 AD USTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.16 Coordination Studies.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.

- 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
- 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
- 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 **PROTECTION**

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

Section 26 27 26 – Wiring Devices

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters and isolated-ground receptacles.
 - 2. Single- and double-pole snap switches.
 - 3. Device wall plates.
 - 4. Pin and sleeve connectors and receptacles.
 - 5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Receptacles, switches, plates, floor outlets, poke through assemblies, service poles and multioutlet assemblies.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70 latest edition or edition enforced by state or local code authority.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Outlets Duplex:
 - a. Hubbell Incorporated- HBL 5362.
 - b. Leviton Mfg. Company Inc.-5362.
 - c. Pass Seymour-CRB5362.
 - d. Pass Seymour -PT5362A (Plug Tail Device).
 - 2. Switches-Single Pole:
 - a. Hubbell- HBL 1221.
 - b. Pass Seymour PS20AC1.
 - c. Leviton Mfg. Company, Inc.- 1221-1
 - 3. Switches-Three Pole:
 - a. Hubbell-HBL1223
 - b. Leviton Mfg. Company, Inc.-1223-2.
 - c. Pass Seymour-PS20AC3.
 - 4. Dimmer Switches Line Voltage:
 - a. Lutron Nova T
 - b. Pass Seymour CD2000

Dimmer must be compatible with Ballast or LED Driver.

- 5. Dimmer Switches 0-10V:
 - a. Synergy ISD
 - b. Cooper SF10P

Dimmer must be compatible with Ballast or LED Driver.

- 6. GFI Receptacles: Weather Resistant:
 - a. Hubbell Incorporated- BR20WR
 - b. Leviton Mfg. Company Inc.-WBR20
 - c. Pass Seymour-WR5362.
- 7. GFI Receptacles: Weather Resistant and Tamper Resistant:
 - a. Hubbell Incorporated- BR2WRTR.
 - b. Leviton Mfg. Company Inc.-TWR20
 - c. Pass Seymour-WR20TR.
- 8. Receptacles: Tamper Resistant:
 - a. Hubbell Incorporated- BR20TR.
 - b. Leviton Mfg. Company Inc.-TWR20
 - c. Pass Seymour-TR5362.

2.2 RECEPTACLES

A. Straight-Blade-Type Receptacles: Comply with UL 498, 20 amp.

- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade 20 amp.
- C. GFCI Receptacles: Straight blade, feed-through type, Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.

2.3 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with greeninsulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.4 SWITCHES

- A. Single- and Double-Pole Switches: Comply with UL 20, 20 amp.
- B. Snap Switches: Heavy-Duty grade, quiet type 20 amp, 120/277 volt.
- C. Live Voltage Dimmer: 120V, 2000 watt, slide to-off. Dimmer must be compatible with ballast or driver.
- D. 0-10V Dimmer: 120/277VAC, capable of three way, max wattage 1200 w 120VAC, 150000 277 VAC, Dimmer must be compatible with ballast or driver. 100 to 1 continuous.

2.5 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: As selected by Architect.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet locations.

2.6 PO E-THROUGH ASSEMBLIES

- A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - 1. Service Outlet Assembly: Recessed type with three (3) compartments that allow for up to three (3) duplex receptacles and/or 12 communication ports and/or 10 AV devices.
 - 2. Size: Selected to fit nominal 6-inch (100-mm) cored holes in floor and matched to floor thickness.
 - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 4. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of four, 4-pair, Category 6 voice and data communication cables.

2.7 FINISHES

- A. Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70.2.
 - 2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. 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.
- C. Remove wall plates and protect devices and assemblies during painting.
- D. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- E. Install weather resistant receptacles in damp and wet locations per N.E.C. requirements.
- F. Install tamper resistant receptacles in homes, apartments, hotel rooms and daycares per N.E.C. requirements.

3.2 CONNECTIONS

- A. Ground equipment according to Division 16 Section Grounding and Bonding.
- B. Connect wiring according to Division 16 Section Conductors and Cables.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 27 26

Section 26 28 13 – Fuses

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in switches.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Fuse size for elevator feeders and elevator disconnect switches.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 PRO ECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ferraz Shawmut, Inc.
 - 2. Little Fuse.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
- B. End Caps: End caps shall be capable of being tested if fuse is blown.
- C. Indicating Feature: Fuse shall have an indicating feature which clearly indicates when fuse is blown.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Motor Branch Circuits: Class R 1, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

Section 26 28 16 – Enclosed Switches and Circuit Breakers

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:
 - 1. Feeder and branch-circuit protection.
 - 2. Motor and equipment disconnecting means.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. RMS: Root mean square.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switch and circuit breaker.
 - 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. Current and voltage ratings.
 - c. Short-circuit current rating.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturerinstalled and field-installed wiring.
 - 3. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in Quality Assurance Article.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70- Latest edition or edition enforced by state and local code authority.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 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. Fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products, -Series.
 - b. General Electric Co.; Electrical Distribution Control Division, TH.
 - c. Siemens Energy Automation, Inc., VBII.
 - d. Square D Co, 3110.

2.2 ENCLOSED SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA S 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA S 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSURES

- A. NEMA AB 1 and NEMA S 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.4 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Basic Electrical Materials and Methods.
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
- C. If the disconnect or enclosed circuit breaker is used as a Main Service Disconnect then the maximum available fault current shall be listed on the device to meet the requirements of NFPA 70:110.24. The labeling shall be engraved plastic. The maximum available fault current shall be obtained from the electrical utility for the secondary side of the utility transformer.

3.3 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.
- D. Maintain all necessary clearances per NFPA-70.

3.4 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.

3.5 AD USTING

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

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. 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 26 28 16

Section 26 32 13 – Packaged Engine Generators

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged diesel-engine generator sets with the following features and accessories:
 - 1. Battery charger.
 - 2. Engine generator set.
 - 3. Muffler.
 - 4. Outdoor enclosure.
 - 5. Remote annunciator.
 - 6. Remote stop switch.
 - 7. Starting battery.
 - 8. Transfer switch.
- B. Related Sections include the following:
 - 1. Section Transfer Switches for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generator sets.

1.3 DEFINITIONS

- A. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.
- B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- C. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance. Include the following:
 - 1. Dimensioned outline plan and elevation drawings of engine generator set and other components specified.
 - 2. Time-current characteristic curves for generator protective device.
- B. Shop Drawings: Indicate fabrication details, dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

- 1. Wiring Diagrams: Detail wiring for power and control connections and differentiate between factory-installed and field-installed wiring.
- C. Field Test and Observation Reports: Indicate and interpret test results and inspection records relative to compliance with performance requirements.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain packaged engine generator and auxiliary components specified in this Section through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- C. Comply with NFPA 70.
- D. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- E. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.7 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner 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.
 - 1. Warranty Period: One year from date of Notice of Final Acceptance. Warranty to include service personnel shall arrive on site within 4 hours.

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. Cummins
 - 2. ohler
 - 3. Caterpillar

2.2 ENGINE GENERATOR SET

A. Furnish a coordinated assembly of compatible components.

- B. Output Connections: Three phase, four wire.
- C. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of item.
- D. Limiting dimensions indicated for system components are not exceeded.
- E. Power Output Ratings: Nominal ratings is 125 kW and 156.25 kVA at .8 p.f. The alternator shall provide a minimum of **323** S VA at an instantaneous voltage dip of 30 . Sustained voltage dip is not acceptable. Provide factory documentation of compliance with these requirements.
- F. Skid: Adequate strength and rigidity to maintain alignment of mounted components without depending on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.

2.3 GENERATOR-SET PERFORMANCE

- A. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.
- B. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
- C. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage recovers to remain within the steady-state operating band within three seconds.
- D. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
- E. Steady-State Frequency Stability: When system is operating at any constant load within rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- F. Transient Frequency Performance: Less than 5 percent variation for a 50 percent step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within five seconds.
- G. Output Waveform: At no load, harmonic content measured line to line or line to neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
- H. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, the system will supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.
- I. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 SERVICE CONDITIONS

A. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

Ambient Temperature: 5 to 40 deg C.
 Relative Humidity: 0 to 95 percent.

3.Altitude: Sea level to 1000 feet (300 m).

2.5 ENGINE

A. Comply with NFPA 37.

B. Fuel: Natural Gas

- C. Rated Engine Speed: 1800 rpm, 4 cycle.
- D. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on engine or skid:
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps or siphons or special tools or appliances.
- E. Coolant acket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment.
- F. The Generator set manufacture shall also be the engine manufacture.

2.6 GOVERNOR

A. Type: Adjustable isochronous, with speed sensing.

2.7 ENGINE COOLING SYSTEM

- A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pump.
- B. Radiator: Rated for specified coolant.
- C. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
- D. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

2.8 ENGINE EXHAUST SYSTEM

- A. Muffler: Critical type, sized as recommended by engine manufacturer. Measured sound level at a distance of 10 feet (3 m) from exhaust discharge, is 85 dBA or less.
- B. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.
- C. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.
- D. Insulation for Mufflers and Indoor Exhaust Piping: As specified in Section Pipe Insulation.

- E. Supports for Muffler and Exhaust Piping: Spring hangers and all-thread rods and vibration hangers as specified in Section Mechanical Vibration Controls and Seismic Restraints; attached to building structure.
- F. Exhaust Piping External to Engine: ASTM A 53, Schedule 40, welded, black steel, with welded joints and fittings. Refer to Section Basic Mechanical Materials and Methods for basic piping installation and joint construction. Refer to Section Hydronic Piping for materials and installation requirements for piping.

2.9 COMBUSTION-AIR-INTA E

A. Description: Standard-duty engine-mounted air cleaner with replaceable dry filter element and blocked filter indicator.

2.10 STARTING SYSTEM

- A. Description: 24-V electric, with negative ground and including the following items:
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Environmental Conditions Paragraph in Service Conditions Article above.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Cranking Cycle: 60 seconds.
 - 5. Battery: Adequate capacity within ambient temperature range specified in Environmental Conditions Paragraph in Service Conditions Article above to provide specified cranking cycle at least three times without recharging.
 - 6. Battery Cable: Size as recommended by generator set manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit complies with UL 1236 and includes the following features:
 - a. Operation: Equalizing-charging rate of 10 A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until battery is discharged again.
 - b. Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.
 - c. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either condition closes contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - d. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.11 CONTROL AND MONITORING

A. Functional Description: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic-transfer switches initiate starting and stopping of the generator set. When the mode-selector switch is switched to the on position, the generator set manually starts. The off position of the same switch initiates generator-set shutdown.

When the generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages are grouped on a common control and monitoring panel mounted on the generator set. Mounting method isolates the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: Include those required by NFPA 110 for a Level 1 system, and the following:
- D. Indicating and Protective Devices and Controls: Include the following:
 - 1. AC voltmeter.
 - 2. AC ammeter.
 - 3. AC frequency meter.
 - 4. DC voltmeter (alternator battery charging).
 - 5. Engine-coolant temperature gage.
 - 6. Engine lubricating-oil pressure gage.
 - 7. Running-time meter.
 - 8. Ammeter-voltmeter, phase-selector switch (es).
 - 9. Generator-voltage adjusting rheostat.
 - 10. Start-stop switch.
 - 11. Overspeed shutdown device.
 - 12. Coolant high-temperature shutdown device.
 - 13. Coolant low-level shutdown device.
 - 14. Oil low-pressure shutdown device.
 - 15. Generator overload.
- E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- F. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Locate audible device and silencing means where indicated. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
 - 1. Engine high-temperature shutdown.
 - 2. Lube-oil low-pressure shutdown.
 - 3. Overspeed shutdown.
 - 4. Remote emergency-stop shutdown.
 - 5. Engine high-temperature prealarm.
 - 6. Lube-oil low-pressure prealarm.
 - 7. Overcrank shutdown.
 - 8. Coolant low-temperature alarm.
 - 9. Control switch not in auto position.
 - 10. Battery-charger malfunction alarm.
 - 11. Battery low-voltage alarm.
- G. Remote Alarm Annunciator: Comply with NFPA 99. Labeled LEDs identify each alarm event. Common audible signal sounds for alarm conditions. Silencing switch in face of panel silences signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flushmounting type to suit mounting conditions indicated.

H. Connect to the building Energy Management System for monitoring. Monitor voltage, on/off, line in and line out.

2.12 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
 - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 - 2. Trip Settings: Matched to generator thermal damage curve as closely as possible.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.13 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1 and specified performance requirements.
- B. Drive: Generator shaft is directly connected to engine shaft. Exciter is rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction prevents mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Excitation uses no slip or collector rings, or brushes, and is arranged to sustain generator output under short-circuit conditions as specified.
- G. Enclosure: Drip proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel provides plus or minus 5 percent adjustment of output- voltage operating band.
- . Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- . Subtransient Reactance: 12 percent, maximum.

2.14 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools. Instruments and control are mounted within enclosure. Provide lighting within the housing per NFPA. Tie to nearby 120v emergency circuit at generator.

2.15 FUEL SUPPLY SYSTEM

A. Comply with NFPA 30 and NFPA 37.

2.16 FINISHES

- A. Indoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.
- B. Outdoor Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer. Color by Architect.

2.17 SOURCE QUALITY CONTROL

- A. Factory Tests: Include prototype testing and Project-specific equipment testing (testing of equipment manufactured specifically for this Project).
- B. Prototype Testing: Performed on a separate engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with those required for Level 1 energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110.
 - 2. Generator Tests: Comply with IEEE 115.
 - 3. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype have been tested to demonstrate compatibility and reliability.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine roughing-in of cooling-system piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for packaged engine generators. Refer to Cast-in-Place Concrete and Basic Electrical Materials and Methods.

3.3 INSTALLATION

- A. Comply with packaged engine generator manufacturers' written installation and alignment instructions, and with NFPA 110.
- B. Set packaged engine generator set on concrete bases.

- C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- D. Install cooling-system piping, accessories, hangers and supports, and anchors for complete installation.
 - 1. Extend drain piping from heat exchangers to point of disposition.
- E. Install exhaust-system piping for natural gas engines. Extend to point of termination outside structure. Size piping according to manufacturer's written instructions.
- F. Install condensate drain piping for natural gas engine exhaust system. Extend drain piping from low points of exhaust system and from muffler to condensate traps and to point of disposition.
- G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
 - 1. Verify that electrical wiring is installed according to manufacturers' submittal and installation requirements. Proceed with equipment startup only after wiring installation is satisfactory.

3.4 CONNECTIONS

- A. Electrical wiring and connections are specified in other Sections.
- B. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values.

3.5 IDENTIFICATION

A. Identify system components according to Electrical Identification.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect fieldassembled components and equipment installation, including piping and electrical connections, and to assist in testing. Report results in writing.
- B. Testing: Perform field quality-control testing under the supervision of the manufacturer's factoryauthorized service representative.
- C. Tests: Include the following:
 - 1. Tests recommended by manufacturer.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:
 - a. 2 Hour Single-step full-load pickup test with resistor bank. Contractor to provide load bank.
 - 3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

- 4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.7 CLEANING

A. On completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators as specified below:
 - 1. Coordinate this training with that for transfer switches.
 - 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 - 3. Review data in maintenance manuals. Refer to Contract Closeout.
 - 4. Review data in maintenance manuals. Refer to Section Operation and Maintenance Data.
 - 5. Schedule training with Owner, through Architect, with at least seven days' advance notice.

6.Minimum Instruction Period: Eight hours.

END OF SECTION 26 32 13

Section 26 36 00 – Transfer Switches

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switch.
 - 2. Remote annunciation and control system.

1.2 SUBMITTALS

- A. Product Data: Include ratings and dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- B. Wiring Diagrams: Detail wiring for transfer switches and differentiate between manufacturer-installed and field-installed wiring. Show both power and control wiring.
- C. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch.
- D. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for load ratings and short-circuit closing and withstand ratings applicable to units for Project.
- E. Qualification Data: For firms and persons specified in Quality Assurance Article.
- F. Field Test Reports: Indicate and interpret test and inspection results for compliance with performance requirements.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing emergency maintenance and repairs at Project site with an four-hour maximum response time.
- B. Source Limitations: Obtain automatic transfer switch, nonautomatic transfer switch, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction.
- D. Comply with NFPA 70.
- E. Comply with NFPA 99.
- F. Comply with NFPA 110.

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. Conventional Transfer Switches:
 - a. ASCO
 - b. Cummins.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- C. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- D. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral are double nominal rating of circuit in which switch is installed.
- E. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6; UL 508, unless otherwise indicated.
- F. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
 - 1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- G. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motoroperated mechanism, mechanically and electrically interlocked in both directions.
- H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuitbreaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units rated 225 A and greater have separate arcing contacts.
- I. Transfer switch shall be manufactured shall be manufactured by the same manufacture of the generator set.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- D. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- E. Provide transfer switch with poles as indicated on the drawings.

2.4 AUTOMATIC TRANSFER-SWITCH FEATURES

- A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
- B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
- C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
- D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes; factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
- E. Test Switch: Simulates normal-source failure.
- F. Switch-Position Pilot Lights: Indicate source to which load is connected.
- G. Source-Available Indicating Lights: Supervise sources via transfer-switch, normal- and emergencysource sensing circuits.
 - 1. Normal Power Supervision: Green light with nameplate engraved Normal Source Available.
 - 2. Emergency Power Supervision: Red light with nameplate engraved Emergency Source Available.
- H. Unassigned Auxiliary Contacts: Two normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
- I. Engine Starting Contacts: One isolated, normally closed and one isolated, normally open, rated 10 A at 32-V dc minimum.
- . Engine Shutdown Contacts: Time delay adjustable from zero to five minutes; factory set for five minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.

- Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days.
 Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - 1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - 2. Push-button programming control with digital display of settings.
 - 3. Integral battery operation of time switch when normal control power is not available.

2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

- A. Functional Description: Include the following functions for indicated transfer switches:
 - 1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - 2. Indication of switch position. Provide four (4) sets of contacts.

2.6 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.7 SOURCE QUALITY CONTROL

A. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 APPLICATION

A. Four-Pole Switches: Switching of line and neutral conductors.

3.2 INSTALLATION

- A. Floor-Mounted Switch: Level and anchor unit to floor.
- B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- C. Identify components according to Electrical Identification.

3.3 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communications requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
3.4 CONNECTIONS

A. Ground equipment as indicated and as required by NFPA 70.

3.5 FIELD QUALITY CONTROL

- A. Testing: Test transfer-switch products by operating them in all modes. Perform tests recommended by manufacturer under the supervision of manufacturer's factory-authorized service representative. Correct deficiencies and report results in writing. Record adjustable relay settings.
- B. Testing: Perform the following field quality-control testing under the supervision of the manufacturer's factory-authorized service representative in addition to tests recommended by the manufacturer:
 - 1. Before energizing equipment, after transfer-switch products have been installed:
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage; proper installation and connection; and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 - 2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown sequence.
- C. Coordinate tests with tests of generator plant and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain transfer switches and related equipment as specified below:
 - 1. Coordinate this training with that for generator equipment.
 - 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 - 3. Review data in maintenance manuals. Refer to Contract Closeout.
 - 4. Review data in maintenance manuals. Refer to Operation and Maintenance Data.
 - 5. Schedule training with Owner, through Architect, with at least seven days' advance notice.
 - 6. Provide a minimum of four hours of instruction.

END OF SECTION 26 36 00

Section 26 43 13 – Surge Protection Devices for Service Entrance and Branch Panels

PART 1 - GENERAL

1.1 DESCRIPTION/SCOPE

- A. The Surge Protection Device (SPD) covered under this section includes all service entrance type surge protection devices suitable for use as Type 1 or Type 2 devices per UL1449 4th Edition, applied to the line or load side of the utility feed inside the facility.
- B. A SPD located at Service Entrance and Distribution and Branch Panels, Switchgear, Motor Control Centers, and Switchboard assemblies as indicated on the drawings.
- C. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devises.

1.2 QUALITY ASSURANCE

- A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
 - 1. UL 1449 4th Edition.
 - 2. UL 1283.
 - 3. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - 4. ANSI/IEEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
 - 5. UL96A
 - 6. IEEE 1100 Emerald Book.
 - 7. National Fire Protection Association (NFPA 70: National Electrical Code).

1.3 SUBMITTALS/QUALITY ASSURANCE – SUBMIT THE FOLLOWING:

- A. Package must include shop drawings complete with all technical information, unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.
- B. Copies of Manufacturer's catalog data, technical information and specifications on equipment proposed for use.
- C. Copies of documentation stating that the Surge Protection Device is listed by UL to UL1449 4th Edition, category code VZCA.
- D. Copies of actual let through voltage data in the form of oscillograph results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.
- E. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50 kHz and 100 MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.
- F. Copies of test reports from a recognized independent testing laboratory, 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.

G. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURER FOR <u>TYPE C SPD's for Service Entrance Application:</u>

- A. Current Technology Transguard3 or TG3 Series **150kA** per mode surge rating or ASCO 560 series.
- B. Approved equivalent. Submission package must be received by engineer 2 weeks prior to bid date shall fully comply with all performance characteristics included in this specification.

2.2 MANUFACTURED UNITS/ ELECTRICAL REQUIREMENTS

- A. Refer to drawing for operating voltage, configuration and surge current capacity per mode for each location, or you may list locations and information here.
- B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 4th Edition, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115 operational voltage test, section 38 in UL1449 will not be accepted.
- C. Unit shall have no more than 10 deterioration or degradation of the UL1449 4th Edition Voltage Protection Rating (VPR) when exposed to a minimum of 5,000 repeated category C3 (20kV/10kA) surges. The SPD manufacturer must provide a test report validating the repetitive surge test was performed.
- D. Protection Modes UL1449 4th Edition VPR(6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347). 3-Phase, 4 wire circuits, (120/240) split phase shall be as follows and comply with test procedures outlined in UL1449 4th Edition section 37.6:

		<u> </u>	B3	C3 Comb.	UL 1449
System			Ringwave	Wave 20kV,	Third Edition
Voltage	Mode	MCOV	6kV, 500A	10kA	VPR Rating
120/240,	L-N	150	490	980	700
120/208	L-G	150	570	980	700
	N-G	150	640	1170	700
	L-L	300	500	1600	1200
277/480	L-N	320	450	1420	1200
	L-G	320	540	1540	1200
	N-G	320	570	1600	1000
	L-L	552	530	2600	2000

E. Electrical Noise Filter- each unit shall include a high performance EMI/RFI noise rejection filter with a maximum attenuation of 54dB per MIL-STD-220B.

- 1. SPD shall include an EMI/RFI noise rejection filter for all L-N modes as well as a removable filter in the N-G mode.
- F. Integral Disconnect Switch (IF REQUIRED)
 - 1. The device shall have an optional NEMA compliant safety interlocked integral disconnect switch with an externally mounted metal 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 600Vac.
 - 4. The SPD device shall be tested to UL1449 4th Edition listed with the integral disconnect switch and the UL1449 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.
- G. The UL1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.
- H. The UL1449 Nominal Discharge Surge Current Rating shall be 20 a
- I. The SCCR rating of the SPD shall be 200kAIC without the need for upstream over current protection.
- . The SPD shall be listed as Type1 SPD, suitable for use in Type1 or Type2 applications.
- . The SPD shall have the following monitoring options.
 - 1. Time Date stamp, duration and magnitude for the following power quality events (sags, swells, surges, dropouts, outages, THD, frequency, Volts RMS per phase)
 - 2. SPD monitoring shall track surge protection and display it as a percentage
 - 3. SPD shall provide a surge counter with three categories to be defined as Low Level surge (100A-500A) Medium Level surge (500A-3,000A) High Level surge (3,000A)

2.3 APPROVED MANUFACTURER FOR <u>*TYPE B SPD's for Branch Panel Application:*</u>

- A. Current Technology Transguard3 or TG3 Series 50 kA per mode surge rating or ASCO 560 series.
- B. Approved equivalent. Submission package must be received by engineer 2 weeks prior to bid date shall fully comply with all performance characteristics included in this specification.

2.4 MANUFACTURED UNITS/ ELECTRICAL REQUIREMENTS

- A. Refer to drawing for operating voltage, configuration and surge current capacity per mode for each location, or you may list locations and information here.
- B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 4th Edition, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115 operational voltage test, section 38 in UL1449 will not be accepted.

- C. Unit shall have no more than 10 deterioration or degradation of the UL1449 4th Edition Voltage Protection Rating (VPR) when exposed to a minimum of 5.000 repeated category C3 (20kV/10kA) surges. The SPD manufacturer must provide a test report validating the repetitive surge test was performed.
- D. Protection Modes UL1449 4th Edition VPR(6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347). 3-Phase, 4 wire circuits, (120/240) split phase shall be as follows and comply with test procedures outlined in UL1449 4th Edition section 37.6:

System Voltage	Mode	MCOV	B3 Ringwave 6kV, 500A	C3 Comb. Wave 20kV, 10kA	UL 1449 Third Edition VPR Rating
120/240, 120/208	L-N	150	490	980	700
	L-G	150	570	980	700
	N-G	150	640	1170	700
	L-L	300	500	1600	1200
277/480	L-N	320	450	1420	1200
	L-G	320	540	1540	1200
	N-G	320	570	1600	1000
	L-L	552	530	2600	2000

- E. Electrical Noise Filter- each unit shall include a high performance EMI/RFI noise rejection filter with a maximum attenuation of 54dB per MIL-STD-220B.
 - 1. SPD shall include an EMI/RFI noise rejection filter for all L-N modes as well as a removable filter in the N-G mode.
- F. Integral Disconnect Switch (IF REQUIRED)
 - 1. The device shall have an optional NEMA compliant safety interlocked integral disconnect switch with an externally mounted metal 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 600Vac.
 - 4. The SPD device shall be tested to UL1449 4th Edition listed with the integral disconnect switch and the UL1449 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.
- G. The UL1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.
- H. The UL1449 Nominal Discharge Surge Current Rating shall be 20kA
- I. The SCCR rating of the SPD shall be 200kAIC without the need for upstream over current protection.
- The SPD shall be listed as Type1 SPD, suitable for use in Type1 or Type2 applications.
- The SPD shall have the following monitoring options available.
 - 1. Time Date stamp, duration and magnitude for the following power quality events (sags, swells, surges, dropouts, outages, THD, frequency, Volts RMS per phase)
 - 2. SPD monitoring shall track surge protection and display it as a percentage
 - 3. SPD shall provide a surge counter with three categories to be defined as
- Low Level surge (100A-500A) Medium Level surge (500A-3,000A) High Level surge (3,000A) SURGE PROTECTION DEVICES FOR

PART 3 - EXECUTION/INSTALLATION

- 3.1 STARTUP The SPD manufacturer's technician shall perform a system checkout and start-up in the field to assure proper installation, operation and to initiate the warranty of the system. The technician will be required to do the following:
 - A. Verify voltage clamping levels utilizing a diagnostic test kit, comparing factory readings to installed readings.
 - B. Verify N-G connection.
 - C. Record information to a product signature card for each product installed.
- 3.2 Unit may be installed on either the line or load side of the main service disconnect. If installed on the line side unit shall be installed with an integral disconnect. If installed on the load side the unit shall be installed on the largest breaker size available. If installed lead length exceeds 5' installer shall use a low impedance (HPI) cable to reduce the lead lengths effect on the installed performance of the SPD.

PART 4 - PRODUCT WARRANTY

- 4.1 Warranty on defective material and workmanship shall be for 15 years.
- 4.2 Copy of Warranty to be sent with submittal.

END OF SECTION 26 43 13

Section 26 51 00 – Interior Lighting

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

- A. ANSI/NFPA 70, National Electrical Code
- B. IEEE C62.41, Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
- C. FCC 47 CFR Part 15, Federal Code Of Regulation (CFR) testing standard for electronic equipment
- D. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products
- E. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources
- F. UL1598, Standard for Safety of Luminaires
- G. NEMA SSL 3-2010, High-Power White LED Binning for General Illumination

1.3 SUMMARY

A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:
 - 1. Dimensions of fixtures.
 - 2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data.
 - 3. Certified results of laboratory tests for fixtures and lamps for photometric performance.
 - 4. Emergency lighting unit battery and charger.
 - 5. Fluorescent and high-intensity-discharge ballasts.
 - 6. Types of lamps.
- B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, method of field assembly, components, features, and accessories.
 - 1. Wiring Diagrams: Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.

- C. Submit product data on luminaires. Product data to include, but not limited to materials, finishes, approvals, photometric performance, and dimensional information.
- D. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in the front end documents.

1.5 DRAWINGS

- A. The drawings, which constitute a part of these specifications, indicate the general location of the luminaires. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.
- B. Photometric layout shall meet or exceed the criteria of the fixtures indicated on drawings.

1.6 QUALITY ASSURANCE

- A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NFPA 70- Latest edition or edition enforced by state and local code authority.
- C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.
- D. LED Luminaires
 - 1. Manufactures of LED luminaires shall demonstrate a suitable testing program incorporating high heat, high humidity and thermal shock test regimens to ensure system reliability and to substantiate lifetime claims.
 - 2. The use of IESNA LM-80 data to predict luminaire lifetime is not acceptable.
 - 3. At time of manufacture, electrical and light technical properties shall be recorded for each luminaire. At a minimum, this should include lumen output, CCT, and CRI. Each luminaire shall utilize a unique serial numbering scheme. Technical properties must be made available for a minimum of 5 years after the date of manufacture.
 - 4. Luminaires shall be provided with a 5 year warranty covering, LEDs, drivers, paint and mechanical component.

1.7 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

1.8 WARRANTY

A. General Warranty: The contractor shall warranty all work for one year after acceptance of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products indicated in the Fixture schedule on the drawings. Manufacture shall submit for prior approval where required at least (10) days prior to bid.
- B. Subject to compliance with these specifications, luminaires shall be as manufactured by manufacture indicated on the drawings or prior approved equivalent.

2.2 FIXTURES AND FIXTURE 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.

2.3 FLUORESCENT LAMP BALLASTS

- A. General Requirements: Unless otherwise indicated, features include the following:
 - 1. Designed for type and quantity of lamps indicated at full light output.
 - 2. Total Harmonic Distortion Rating: Less than 10 percent.
 - 3. Sound Rating: A.
- B. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in General Requirements Paragraph above:
 - 1. Encapsulation: Without voids in potting compound.
 - 2. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail. Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surving lamps if one or more lamps fail.
 - 3. Operating Frequency: Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz and 52 kHz to avoid interference with infrared devices and eliminate visible flicker.
 - 4. Ballast shall provide Independent Lamp Operation (ILO) for Programmed Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.
 - 5. Ballast shall operate from 60 Hz input source of 120V through 277V or 347V as applicable with sustained variations of /-10 (voltage and frequency).
 - 6. Ballast starting voltage shall be equal to or greater than 550v.
- C. Ballasts for Compact Lamps in Recessed Fixtures: Unless otherwise indicated, additional features include the following:
 - 1. Type: Electronic or electromagnetic, fully encapsulated in potting compound.
 - 2. Power Factor: 90 percent, minimum.

- 3. Operating Frequency: 20 kHz or higher. 42 kHz or higher.
- 4. Flicker: Less than 5 percent.
- 5. Lamp Current Crest Factor: Less than 1.7.

2.4 EXIT SIGNS

- A. Internally Lighted Signs: As follows:
 - 1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

2.5 LAMPS

- A. Fluorescent Color Temperature and Minimum Color-Rendering Index: Refer to drawings.
- B. 4 foot lamps shall be 28 watt, 68,000 rated life 12 hour on with instant start ballast and 90,000 12 hour on with programmable start. Initial lumens 2650, minimum CRI of 82 and a 96 lumen maintenance. Approved lamp is Philips Energy Advantage.
- C. All fluorescent lamps shall be low mercury.

2.6 LED LUMINAIRES

- A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- B. Material and specifications for each luminaire are as follows:
 - 1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply)
 - 2. Each luminaire shall be rated for a minimum operational life of 50,000 hours and to LM-70 lumen depreciation standards. This life rating must be conducted 40C ambient temperature.
 - 3. The rated operating temperature range shall be -30° C to 40° C.
 - 4. Each luminaire is capable of operating above 100°F 37°C, but not expected to comply with photometric requirements at elevated temperatures.
 - 5. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.
 - 6. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
 - 7. Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
 - 8. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an equivalent standard from a nationally recognized testing laboratory.
- C. Technical Requirements

1.

- Electrical
 - a. Power Consumption: Maximum power consumption allowed for the luminaire shall be determined by application. The luminaire shall not consume power in the off state.
 - b. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
 - c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
 - d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.

- e. Each Luminaire shall have UL Listed Class II power supplies. Class I power supplies will not be acceptable.
- f. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
- g. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
- h. Drivers shall have a Class A sound rating
- 2. Thermal Management
 - a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
 - b. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
 - c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
 - d. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.
 - e. The heat sink material shall be aluminum

2.7 FIXTURE SUPPORT COMPONENTS

- A. Comply with Basic Electrical Materials and Methods, for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.
- C. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- D. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.8 FINISHES

- A. Fixtures: 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 INSTALLATION

- A. Fixtures: 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 fixture.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from fixture corners.

- 2. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- C. Suspended Fixture Support: As follows:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Provide instruments to make and record test results.
- C. Tests: As follows:
 - 1. Verify normal operation of each fixture after installation.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
 - 3. Verify normal transfer to emergency source and retransfer to normal.
 - 4. Report results in writing.
- D. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- E. Corrosive Fixtures: Replace during warranty period.

3.4 CLEANING AND AD USTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

END OF SECTION 26 51 00

Section 26 56 00 – Exterior Lighting

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.

1.3 DEFINITIONS

- A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.
- B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Materials and dimensions of luminaires and poles.
 - 2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data.
 - 3. Certified results of laboratory tests for fixtures and lamps for photometric performance.
 - 4. High-intensity-discharge luminaire ballasts.
 - 5. LED and Driver information.
- B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.
- C. Maintenance Data: For lighting units to include in maintenance manuals specified in specifications.

1.5 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 acceptable to authorities having jurisdiction
- B. Comply with NFPA 70- Latest edition or edition enforced by state and local code authority.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

- A. Store poles on decay-resistant treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.7 WARRANTY

A. General Warranty: The contractor shall warranty all work for one year after acceptance of the project for HID and fluorescent and (5) year after acceptance of the project for LED.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products indicated in the Fixture schedule on the drawings. Products indicated in the fixture schedule shall meet the requirements of this specification. Manufacture shall submit for prior approval where required at least (10) days prior to bid.

2.2 HID / FLUORESCENT LUMINAIRES

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- 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. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.
- D. High-Intensity-Discharge Ballasts: Comply with ANSI C82.4. Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.
 - 1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
 - 2. Single-Lamp Ballasts: Minimum starting temperature of minus 40 deg C.
 - 3. Open-circuit operation will not reduce average life.
 - 4. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.
 - 5. Noise: Uniformly quiet operation, with a noise rating of B or better.

2.3 LUMINAIRE SUPPORT COMPONENTS

A. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 110

mph (160 km/h) with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

- B. Finish: Match finish of pole/support structure for arm, bracket, and Tenon mount materials.
- C. 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.
- D. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.
- E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- F. Concrete for Pole Foundations: Comply with Cast-in-Place Concrete.
 - 1. Design Strength: 3000-psig (20.7-MPa), 28-day compressive strength.

2.4 LED LUMINAIRES

- A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules. The luminaires need to meet the requirements below.
- B. Material and specifications for each luminaire are as follows:
 - 1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
 - 2. Each luminaire shall be rated for a minimum operational life of 50,000 hours at an average operating time of 11.5 hours per night. This life rating must be conducted 40C ambient temperature.
 - 3. The rated operating temperature range shall be -30° C to 40° C.
 - 4. Each luminaire is capable of operating above 100°F 37°C, but not expected to comply with photometric requirements at elevated temperatures.
 - 5. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.
 - 6. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
 - 7. Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
 - 8. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an equivalent standard from a nationally recognized testing laboratory.

C. Technical Requirements

- 1. Electrical
 - a. Power Consumption: Maximum power consumption allowed for the luminaire shall be determined by application. The luminaire shall not consume power in the off state.
 - b. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
 - c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
 - d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
 - e. Surge Suppression: The luminaire on-board circuitry shall include fused surge protection devices (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD shall protect the luminaire from damage and failure for common mode transient peak voltages up to 10 kV (minimum) and transient peak currents up to 5 kA (minimum). SPD shall conform to UL 1449 depending of the components used in the design. SPD performance shall be tested per the procedures in ANSI/IEEE C62.41-1992 (or current edition) for category C (standard). The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.
 - f. Each Luminaire shall have integral UL Listed Class II power supplies. Class I power supplies will not be acceptable.
 - g. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
 - h. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
 - i. Drivers shall have a Class A sound rating.
- 2. Photometric Requirements
 - Optical Assemblies: LEDs shall be provided with discreet over optical elements to provide IESNA Type II, III, IV or V distributions. Additional distributions for spill light control shall be utilized when light trespass must be mitigated. Mitigation must take place without external shielding elements. Optical assemblies shall have a minimum efficiency of 85 regardless of distribution type. For Type II and Type III distributions street side efficiencies shall be a minimum of 80 . All LEDs and optical assemblies shall be mounted parallel to the ground. All LEDs shall provide the same optical pattern such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.
 - b. Illuminance: The illuminance shall not decrease by more than 30 over the expected operating life. The measurements shall be calibrated to standard photopic calibrations.
 - c. Light Color/Quality: The luminaire shall have a correlated color temperature (CCT) range of 4,000 to 4,500 . The color rendition index (CRI) shall be 70 or greater. Binning of LEDs shall conform to ANSI/ G. NEMA SSL 3-2010.
 - d. Backlight-Uplight-Glare: The luminaire shall not allow more than 10 percent of the rated lumens to project above 80 degrees from vertical. The luminaire shall not allow more than 2.5

percent of the rated lumens to project above 90 degrees from vertical. Backlight and Glare ratings as per fixture schedule and calculated per IESNA TM-15.

- 3. Thermal Management
 - a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
 - b. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
 - c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
 - d. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.
 - e. The heat sink material shall be aluminum.
- 4. Physical and Mechanical Requirements
 - a. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.
 - b. The assembly and manufacturing process for the LED luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.
 - Luminaires shall be capable of withstanding cyclical loading in (G Acceleration of Gravity): a minimum peak acceleration level of 3.0 G peak-to-peak sinusoidal loading with the internal driver installed, for a minimum of 100,000 cycles without failure of any luminaire parts. Testing to be performed in three planes: a horizontal plane parallel to the direction of mounting, a horizontal plane perpendicular to the direction of mounting and the vertical plane.
 - d. The housing shall be designed to prevent the buildup of water on the top of the housing. Exposed heat sink fins shall be oriented so that water can freely run off the luminaire, and carry dust and other accumulated debris away from the unit.
 - e. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-66 (minimum) to protect all optical components
 - f. The electronics/power supply enclosure shall meet the requirements for NEMA/UL wet location.
 - g. Each mounted luminaire may be furnished with or without a photoelectric unit receptacle as per fixture schedule.
 - h. Door shall be hinged and secured to the housing in a manner to prevent its accidental opening.
 - i. The circuit board and power supply shall be contained inside the luminaire. Electrolytic capacitors used in the power supplies shall be rated for -40°F to 220°F (-40°C to 105°C), long life (5000 hours), and operated at no more than 70 of their rated voltage, and 70 of rated current.

- 5. Materials
 - a. Housings shall be fabricated from materials that are designed to withstand a 3000-hour salt spray test as specified in ASTM Designation: B117.
 - b. Each refractor or lens shall be made from UV inhibited high impact plastic such as acrylic and be resistant to scratching.
 - c. Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. The len(s) of the luminaire are excluded from this requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Concrete Foundations: Construct according to 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 Section Cast-in-Place Concrete for exposed finish.
- B. Install poles as follows:
 - 1. Use web fabric slings (not chain or cable) to raise and set poles.
 - 2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 3. Secure poles level, plumb, and square.
 - 4. Grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space.
 - 5. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- C. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values.
- B. Ground metal poles/support structures according to Section Grounding.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged units.
- B. Advance Notice: Give dates and times for field tests.
- C. Provide instruments to make and record test results.

D. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.4 CLEANING AND AD USTING

- A. Clean units after installation. Use methods and materials recommended by manufacturer.
- B. Contractor to aim any adjustable luminaries per architect, engineer or owner's requirements. Contractor to provide aiming at night and provide all necessary equipment needed to aim luminaires.

END OF SECTION 26 56 00

Section 27 05 36 – Cable Trays For Communications Systems

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:1. Wire-mesh cable tray.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.



- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

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.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 WIRE-MESH CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cablofil Inc.
 - 2. Cooper B-Line, Inc.
 - 3. Chatsworth
 - 4. Cope Tyco/Allied Tube Conduit
- B. Description:
 - 1. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.
 - a. Basket Cable Trays: Size as indicated on drawings. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100mm).
 - 2. Provide a minimum of 12" clearance above all cable trays for future access.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. 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.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. oin aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg).
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- . Support bus assembly to prevent twisting from eccentric loading.
- . Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- M. Support wire-basket cable trays with trapeze hangers and/or wall brackets.
- N. Make changes in direction and elevation using manufacturer's recommended fittings.
- O. Make cable tray connections using manufacturer's recommended fittings.
- P. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 Penetration Firestopping.
- Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

R. Install cable trays with enough workspace to permit access for installing cables.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified.
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, Size of Equipment Grounding Conductors.

3.3 CABLE INSTALLATION

A. Cable installation by others.

3.4 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 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
 - 1. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 2. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 3. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 4. Check for improperly sized or installed bonding jumpers.
 - 5. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 6. 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.
- B. Prepare test and inspection reports.

3.6 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 27 05 36

Section 27 13 00 – Voice and Data Systems

PART 1 - GENERAL



1.1 SUMMARY:

- A. This section includes the following: Inside station cables, multi-pair inside telephone cables, fiber optic cable, backboards, racks, inner duct, cross connects and outlets for voice and data use to each station outlet location as shown on the Drawings.
 - 1. Conduits for voice and data between buildings as shown on the Drawings or as indicated in specifications.
 - 2. Backboards, telephone cable connecting patch panels, relay rack, mounting brackets, splice closures, building protectors, and associated hardware for bundling, racking and cross-connecting voice cables as shown on the Drawings or indicated in specifications. Provide 20 percent future capacity on all patch panels and connecting blocks.
 - 3. Backboards, relay rack, mounting brackets and associated hardware for bundling, racking and cross-connecting data cables as shown on the Drawings or as indicated in specifications.
 - 4. Fiber cables, fiber distribution panels, and associated hardware for bundling, racking and terminating fiber cable as shown on the Drawings.
 - 5. Category 6, four-pair communications cable (for voice) and Category 6 (Cat 6), four-pair communications cable (for data) to each voice/data outlet location as indicated on Drawings. Furnish a four (4) position face plate at each location.
 - 6. 4 position, 8 conductor (4 pair) modular voice/data jacks at each telephone/data outlet shown on Drawings and as specified herein.
 - 7. Single, 8 conductor (4 pair) modular voice jack at each telephone only outlet shown on Drawings and as specified herein.
 - 8. Relay racks with patch panels, and wire management frame for terminating data and voice station cables.
 - 9. Duplex receptacles and ground bus, and connection of ground bus to building system.
 - 10. Station wiring conduit and conduits between communication closets, and inner duct as described on the Drawings.

1.2 QUALITY ASSURANCE:

- A. All work and equipment shall conform to the applicable portions of the following specifications, codes and regulations:
 - 1. Building Industry Consulting Services International (BICSI)
 - 2. Telecommunications Distribution Methods Manual
 - 3. BOCS and AT T Plant Standards

- 4. ANSI/EIA/TIA Standards
- 5. National Electrical Code (NEC)
- 6. State Codes
- B. Maintenance Considerations:
 - 1. The cable and wire system shall be installed to maximize the safety, maintainability, and performance effectiveness of maintenance personnel and minimize the demands upon skills, training, and manpower. Splices/terminations shall be placed and supported with convenient accessibility so as to maximize the efficiency and ease with which it can be maintained. No cables shall be spliced unless as shown on plans or approved by Engineer.
- C. Cable and wire identification, testing, and documentation shall be specified in Part 3.00 herein.

1.3 SHOP DRAWINGS:

A. Shop drawings shall be submitted for review and shall include complete catalog and other information shown to describe the cables, wire, and equipment proposed to be furnished and numbered locations for all data and voice locations.

PART 2 - PRODUCTS

2.1 MULTI-PAIR INSIDE TELEPHONE CABLE (RISER):

A. Inside telephone, multi-pair, voice cable shall be 24 AWG copper, communications riser cable (CMR), unshielded twisted pair, Category 3. Cable shall contain pair quantity as shown on the drawings. Cable shall comply with the following standards and be suitable for the following applications:

Digital Voice	-IBM 36/38/AS400
ISDN	-IEEE 802.3 (1 Base 5, 10BaseT)

2.2 VOICE/DATA STATION CABLE:

- A. Industry standard Category 6 communications wire and cable shall be used for all telephone applications. Station Cable shall be four-pair, unshielded, twisted pair, Category 6, Inside-station cable, and shall be constructed of solid 23 gauge annealed copper. Cable shall have Category 6 transmission characteristics as specified by ANSI/EIA/TIA-568B. Each conductor shall be insulated with a continuous layer of fluorinated ethylene propylene (FEP). The sheath shall be all weather, flame resistant. Station wire shall be constructed of 4 twisted pair sharing one sheath. General Cable GenSpeed 6500, Hubbell NEXTSPEED or prior approved equal.
- B. Voice/Data station wiring shall be Category 6 (Cat 6) communications wire and cable. Station Cable shall be four-pair, unshielded, twisted pair, inside-station cable, and shall be constructed of solid 23 gauge annealed copper. Each conductor shall be insulated with a continuous layer of fluorinated ethylene propylene (FEP). The sheath shall be all weather, flame resistant, polyvinyl chloride. Station wire shall be constructed of 4 twisted pair sharing one sheath. Voice/Data cable shall be terminated in a 110 rack mounted patch panel. The use of 66 or 110 patch panels is not allowed for station. Cable shall have Category 6 transmission characteristics as specified by ANSI/EIA/TIA-568B and meet the following performance characteristics. General Cable

GenSpeed 6500, Hubbell NEXTSPEED or prior approved equal.

Highest Test Freq.	350 MHz
Min. 10dB ACR Power Sum	100 MHz
Min. 0dB ACR Power Sum	165 MHz
Attenuation less than/equal to 33dB200	MHz

- C. Cables routed in air plenum shall have a sheath and conductor insulation constructed of material so as to be classified as type CMP as defined by the NEC 800-3(b)(3).
- D. Cable jacket color shall be as follows:

White
BlueVoice
DataFinal color shall be approved by the engineer in shop drawings.Engineer has the right to change
color of the cables.

2.3 CROSS-CONNECT WIRE:

A. Cross-connect wire and fiber jumpers shall be furnished and installed by Contractor. Contractor shall provide enough patch cables and fiber jumpers for all possible connections. Cross-connect must be factory certified Category 6 for voice connections and compatible with Category 6 for data wiring. The fiber jumper shall be a duplex, buffered, graded-index fiber, evlar yarn over each fiber cladding, and a flame-retardant PVC jacket.

2.4 COMMUNICATIONS OUTLET:

- A. Telephone and data outlets shall be a combination voice/data communication unit. Wall mounted outlets shall be flush mounted in a double gang utility box and covered with voice and data device plates. Raceway mounted outlets shall be flush mounted and covered with voice and data device plates. Complete outlet shall consist of utility box, communication assembly devices, cover plate, and jack inserts. All voice/data outlet inserts shall be eight (8) position/eight (8) conductor, insulation displacement, Hubbell part number HX 6xx only, EIA/TIA 568B Category 6 compliant.
- B. Communications outlets shall be furnished by one manufacturer. Outlet shall be furnished with 4-position, Category 6 compliant, R -45 modular jacks. Each outlet shall consist of voice jacks and data jacks in the locations as shown on Drawings. Voice only outlets shall consist of one (1) voice jack. Data jacks shall be compatible with Category 6 wiring.
- C. Outlets shall consist of the following items:

- 2. Data ack Inserts.
- 3. Voice ack Inserts.
- 4. Blank Inserts.
- D. The device plate colors shall be as selected by architect per space.

2.5 CONNECTING BLOC S:

A. Voice feeder and station cables shall be terminated on Category 6 compliant, type 110 patch panels. All panels shall be 48-port type.

- B. The patch panels shall support 100 MHz cross connect transmission for UTP cabling systems utilizing Category 6 performance rated cable. Terminations shall use 110-IDC (Insulating Displacement Connector) field made continuous to the 8-pin modular jack on front of panel via Printed Circuit interconnections. The panel shall mount on nineteen (19) inch rack and be fully EIA/TIAT568B compliant. Panels will be T568B wiring.
- C. Outlets shall have circuit identification holders and labels. The labels shall be used to identify outlets per the face plate detail on drawings.

2.6 RELAY RAC :

- A. Relay rack shall be open frame design, tubular metal, 19 wide x 84 high for 19 rack mounting equipment. Panel mounting holes are to be #12-24 tapped on EIA universal spacing on both front and rear of rack. Rack to be self supporting with base suitable to floor mount. Rack shall be suitable for front and rear mounting of patch panels and/or Owner furnished concentrator hubs. Rack shall be furnished with 3.5 high wire management frames and supports as shown on the Drawings, or as required for installation. Rack will be furnished with a horizontal manager for each patch panel, 2 vertical managers and a Chatsworth cable run kit and American Power Conversion (APC) double sided fixed rack shelf for APC netshelter enclosure or approved equal.
- B. Relay rack to be Bud Industries ARR-1272, Homaco 19-84-T2S, ICCMSR1984 or approved equal. Wire management support shall be two-position organizer panel.

2.7 CABLE MANAGEMENT:

A. Cable management or cable organizers shall be metal panels equipped with distributing rings and are to be used to provide vertical and horizontal paths between terminal blocks for routing cables. Cable management or cable organizers shall be a combination style to handle front, rear, vertical and horizontal cable/patch cords pathways in a standard nineteen (19) inch rack space. The oversized front rings meet larger-capacity requirements for Category 6 patch cords and rear management reduces tension stress/bending radius of cables routed from inside or outside of vertical channels. The panel will have metal legs to allow cables to pas behind the panel. A white, fire-retardant polycarbonate plastic frame 110-type jumper trough shall be provided. Trough shall be designed to accommodate patch cords and outlet cables. Troughs shall be installed between each 100 pair wiring block and at the top and bottom of each column for routing purposes. Cable organizers shall be Leviton 49252-PCM, Homaco HFM-19-2 or approved equal.

2.8 FIBER DISTRIBUTION PANEL:

- A. Fiber cables shall be routed to FIBER DISTRIBUTION UNIT. Unit shall be rack mounted with total capacity of twelve (12) or twenty-four (24) bulkheads and /or splices.
- B. The MAIN FIBER DISTRIBUTION FRAME shall be placed on the first floor. This frame shall provide a termination and service access point for fiber optic circuits, cross-connect or interconnect fiber cables to the equipment by means of jumper cables, and centralized all access to the fiber terminations in the building. This fiber distribution system shall consist of a frame, shelves, modules and associated hardware. Main distribution frame shall be Panduit #FRME72, or Siecor #FDF-576-20, Corning CCH-04U (72port) CCH-02U (24port) or approved equal.
- C. The FIBER COMBINATION SHELVES shall allow termination of buffered cables or direct termination of outside plant cables. The shelf is to be used as a termination shelf only (direct connector termination) or used as a splice and termination shelf by using pigtails. The shelf will be equipped with the following: twenty-four (24) or seventy-two (72) fiber capacity, hinged front

and rear doors, knockout for optional lock mechanism, universal shelf mounting brackets, cable clamp brackets for termination for cables, blank labels for identifying fiber splices and terminations, splice tray housing, splice tray housing that slides out for easy access, and other associated hardware. These shelves will be rack mount. AVAYA Technologies #LSC2U-024/5 (24 fiber combination), Hubbell #4W311-0TE (24 fiber combination), AVAYA Technologies #LSC1U-072/12 (72 fiber combination), Hubbell #4W711-0TE (72 fiber combination), Corning CCH-04U (72port) CCH-02U (24port) or equal.

2.9 FIBER BREA -OUT IT:

A. Fiber break-out kits shall be used to terminate fiber into protective buffer tubes. it permits separation and protection of individual fiber elements. its shall be Siecor, Belden, AT T, Corning or approved equal.

2.10 CORRUGATED FLEXIBLE CONDUIT:

- A. Corrugated flexible conduit, or INNER DUCT, shall be a non-metallic, flexible conduit intended for power and communications applications. Duct shall be suitable for underground installations, and suitable for installation inside larger power or communications conduits.
- B. The corrugated duct shall be sized as shown on the Drawings. Duct shall be orange in color and shall be furnished on 250' reels or in 250' coils. Duct manufacturer shall furnish required PVC fittings.
- C. All vertical fiber optic riser cables shall be installed in riser rated inner duct. The inner duct shall extend to the relay rack as near as practical to the fiber termination shelf.

2.11 PATCH PANELS:

A. The patch panels shall support 100 MHz cross connect transmission for UTP cabling systems utilizing Category 6 performance rated cable. Terminations shall use 110-IDC (Insulating Displacement Connector) field made continuous to the 8-pin modular jack on front of panel via Printed Circuit interconnections. The panel shall mount on nineteen (19) inch rack and be fully EIA/TIAT568B compliant. Panels will be T568B wiring.

2.12 FIBER OPTIC CABLE:

- A. Fiber optic cable shall be as shown on the Drawings, breakout style suitable for indoor/outdoor applications. Each individually jacketed fiber shall contain evlar strength member to allow direct termination of cable. Cable shall be UL listed and constructed in accordance with EIA/TIA 568 requirements.
- B. Fiber optic cables shall meet the following requirements: Single Mode shall be OS2 Multi-Mode shall be OM3 for up to 500 meters and OM4 for over 500 meters

2.13 FIBER CONNECTORS

A. Fiber cable connectors shall be SC style connectors, Panduit, Siecor, Corning or approved equal.

2.14 OUTDOOR IN-GRADE BOXES

- A. Furnish and install lightweight pre-fabricated pull box where shown on the Drawings. Power service box shall be nominal 24 x 36 size with cover for light traffic duty. Box shall be stack able to obtain required depth. Cover shall be marked with TELEPHONE logo. A bottom is required on box.
- B. Pull box shall be pre-cast concrete construction or pre-cast heavy weave fiberglass and polymer concrete. Pull box shall be equal to Quazite Composite "PC" Style, or Associated Plastics PH3660/36 VAULT Series.

2.15 VIDEO CABLING

- A. The contractor shall provide RG6 coaxial cabling from the video jack locations indicated by the TV symbols on the drawings. The RG6 shall be plenum rated and shall be homerun to the nearest access control communications room.
- B. The contractor shall provide an RG11 coaxial cable between access control communications rooms the main communications room.
- C. Provide and "F" connector at every jack.
- D. Cable shall be plenum in plenum rated ceilings.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Unless otherwise specified, all communications systems shall be permanently installed and connected to the wiring systems. The systems must be installed according to manufacturer standards and recommendations.

3.2 TELEPHONE/DATA SYSTEM GENERAL REQUIREMENTS:

- A. All cables, wires, and equipment shall be securely and neatly installed. Inside routing shall be installed parallel and perpendicular to existing structural lines and members.
- B. Each station wire shall be plainly marked at its patch panel end with the room number to which it is connected, and terminated on the termination blocks or patch panel.
- C. Voice/data cables shall be routed above ceilings utilizing cable hooks. Cables must not be secured to hooks. Provide hooks a minimum of four feet on center.
- D. Contractor shall maintain recommended Category 6 bending radius, pulling tension, and cable support requirements. Cable ties may be finger tight, however, not so tight so they distort the outer jacket of the cable.
- E. Cable suspended above an open ceiling shall not rest on ceiling tiles or lighting fixtures, and shall be supported from roof structure at 4' intervals.
- F. Voice/data system wiring shall be installed in accordance with NEC Article 800-5 and 6 requirements.

3.3 TELEPHONE/DATA CABLE INSTALLATION:

- A. Station cable installation shall consist of the following:
 - 1. All conduits stubbed up in ceiling spaces shall have conduit bushing at end of conduit.
 - 2. From the outlet location to the telephone backboard, Contractor shall furnish and install voice and data cables as per Drawings. Voice only stations shall have one (1), four (4) pair station cable.
 - 3. Each cable shall also be labeled per face plate detail.
 - 4. Voice jack shall be installed in top left position at each location.
 - 5. At modular furniture locations contractor shall provide outlets and cable indicated on the drawings. Cable shall be installed and terminated in the modular furniture complete from outlet to patch panel. Contractor to install cable in modular furniture raceway then to flexible conduit and to a junction box in adjacent wall. Refer to detail on drawings.
 - 6. Provide 4'-0" of slack at each outlet location. Slack shall be in ceiling space.

3.4 FIBER CABLE INSTALLATION:

- A. Fiber cables shall be terminated using SC type connectors. Connectors shall be attached using hot melt, ultraviolet, epoxy or heat curable.
- B. All multi-mode fiber cables shall be terminated at both ends and Contractor shall coordinate termination of fibers at source end.

3.5 COMMUNICATIONS SYSTEM QUALIFICATIONS:

A. The communications system installer shall be experienced in the design, fabrication and installation of communications premise distribution systems of similar size and scope to this project. Installation technicians shall be manufacturer certified in At T Systimax Structured Cabling System, AMP Netconnect Cabling System, Siecor wiring systems, or equal.

3.6 CABLE/WIRE IDENTIFICATION:

- A. The following labeling procedure shall be completed by the Contractor after each cable has been installed and connected:
 - 1. Each cable pair shall be plainly marked at the patch panel end.
 - 2. All outlets shall be permanently marked or labeled on the jack faceplate ID number.
 - 3. All cables shall be legibly and permanently labeled at each end using wrap-around/stick-on label systems or approved equal.
 - 4. In rooms where more than one jack exists, the jacks shall be labeled per the faceplate detail.

- 5. All conduits, except those used for individual station jacks, shall be clearly and permanently marked or labeled at both ends, indicating the location of the other end of the conduit.
- B. All cable and wiring identification shall be in compliance with ANSI/TIA/EIA 606 Structured Cabling System standards. No hand-written labels will be accepted on face place and patch panels.

3.7 DOCUMENTATION AND TESTING:

- A. Upon completion of construction, the Contractor shall provide "as installed" drawings showing the exact placement of all outlets, cables, conduits and connecting hardware called for in this section.
- B. Voice and data wiring shall be tested upon completion of installation. In order for any voice cable to be accepted, the number of defective pairs shall be limited to a maximum of one percent (1) of the total number of pairs in the cable. Any cable having more than the maximum acceptable number of defective pairs shall be replaced at the Contractor's expense. The cable test results shall be provided with the "as installed" drawings upon the completion of construction.
- C. Voice and Data station cables shall contain no defective pairs.
- D. Testing Procedures
 - 1. Testing shall be performed in the presence of a representative as designated by the architect or engineer. Sufficient advanced notice of test dates shall be provided to coordinate test dates.
 - 2. All voice (station, riser outside plant) cables and associated connection hardware shall be tested and documented by the Contractor. The test procedure shall demonstrate as a minimum:
 - a. Continuity (more than 2,600 ohms is considered an open)
 - b. Shorts (60,000 ohms or less is considered a short)
 - c. Proper polarity (tip and ring correct)Proper polarity (tip and ring correct)
 - d. Proper termination (splits wrong terminations)
 - e. Proper ground and shield bonding
 - f. Grounded conductors (60,000 ohms or less to ground is considered a fault)
 - g. Detection of A/C or DC power on any conductor (power fault test)
 - h. User's equipment must function normally when connected to the installed wiring
 - 3. All UTP data station and riser cables and associated connection hardware shall be tested to certify the performance category of the link as installed. All Category 6 station cables shall be tested in accordance with procedures laid out in EIA/TIA 568B.2-1. Written (printed) test results for each cable shall include all of the field test parameter results. Any cable that fails testing shall be reported along with the procedures used to rectify the failure (IE. Replaced cable, re-terminated the jack, etc.). Contractor tests shall utilize a category six (6) complaint cable tester. Fluke and HP are approved tester. Electronic results for each UTP Category 6 four pair cable shall be submitted as a part of the Contractors as built project performance acceptance records. In addition to the above information the documentation shall include a pass/fail indication for the specified cable, the test date, the serial number and software version of the scanner used, and a copy of the calibration certificate of the scanner. Necessary applications for reading the results shall be provided by the Contractor. This document can be found in the EIA/TIA Telecommunications Building Wiring Standards.

- 4. The Contractor shall test, certify and document each fiber optic conductor to meet the following attenuation specifications:
 - a. Power meter test: (cable length per 1000'times 1.22) connector loss splice loss acceptable loss in dB 850 nm, nominal. End-to-end testing shall include all connectors and jumpers. The Contractor shall supply all required meters, jumpers and light sources for this test.
 - b. OTDR Test shall be performed by the Contractor on each fiber strand and on each fiber segment installed at both 850 nm and 1300 nm for multimode cable. If single mode cable is installed OTDR tests shall be performed at both 1310 nm and 1510 nm. Two sets of hard copy printouts of the OTDR graphs for each fiber strand shall be presented to the A/E. Fiber termination made on site shall be of factory quality and tested for attenuation loss not to exceed 0.5 dB per mated connection at 1300 nm for multimode fiber and 1550 nm for single mode fiber. Fiber connector terminations shall be made by a factory trained technician with ample field experience. Fiber technician certification shall be submitted to the A/E with the fiber test documentation.
- E. Prior to testing of any communications cable/wire and hardware, the Contractor shall notify The Architect in writing, at least two (2) weeks in advance of testing. Contractor shall furnish hard copy of all test reports to Architect for approval prior to completion and final acceptance of project.
- F. Submit documentation regarding the manufacturer's extended warranty. The length of the extended warranty shall be a minimum of twenty (20) years. The documentation shall include a sample of the warranty that shall be provided to the Owner when the installation is complete, as well as procedures for handling warranty issues. The warranty shall be for the complete system.

END OF SECTION 27 13 00



Section 28 31 11 – Fire Alarm System

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. This Section includes fire alarm systems.
 - B. Definitions:
 - 1. FACP: Fire alarm control panel.
 - 2. LED: Light-emitting diode.
 - 3. Definitions in NFPA 72 apply to fire alarm terms used in this Section.
 - C. System Description:
 - 1. Noncoded, Analog addressable system; multiplexed signal transmission dedicated to fire alarm service only.
 - D. Performance Requirements:
 - 1. Comply with NFPA 72 latest edition or edition enforced by state or local code authority.
 - 2. Fire alarm signal initiation shall be by one or more of the following devices:
 - a. Manual stations.
 - b. Heat detectors.
 - c. Smoke detectors.
 - d. Automatic sprinkler system water flow.
 - 3. Fire alarm signal shall initiate the following actions:
 - a. Alarm notification appliances shall operate continuously and be synchronized as required per code.
 - b. Identify alarm at the FACP and remote annunciators.
 - c. Transmit an alarm signal to the remote alarm receiving station.
 - d. Shut down heating, ventilating, and air-conditioning equipment over 2000 cfm.
 - e. Record events in the system memory.
 - 4. Supervisory signal initiation shall be by one or more of the following devices or actions:
 - a. Operation of a fire-protection system valve tamper.
 - 5. System trouble signal initiation shall be by one or more of the following devices or actions:
 - a. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
 - b. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
 - c. Loss of primary power at the FACP.
 - d. Ground or a single break in FACP internal circuits.
 - e. Abnormal ac voltage at the FACP.
 - f. A break in standby battery circuitry.

- g. Failure of battery charging.
- h. Abnormal position of any switch at the FACP or annunciator.
- 6. Resetting of other systems:
 - a. Resetting of duct detectors shall be from the panel.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
 - 2. Device Address List: Coordinate with final system programming.
 - 3. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
 - 4. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
 - 5. Batteries: Size calculations.
 - 6. CAD drawings with device locations, device ratings, cable routing, cable size/type, etc. indicated on floor plans.
 - 7. All shop drawings are to be electronic in nature and submitted in PDF form. Paper shop drawings will not be reviewed.
- C. Field quality-control test reports per NFPA 72.
- D. Operation and maintenance data.
- E. Submittals to Authorities Having urisdiction: In addition to distribution requirements for submittals specified in Submittals, make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Complete all required form. Contractor is responsible for all required fees. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.
- F. All drawings shall be done in AutoCAD 14 format or newer. Fire Alarm devices with any notation are to clearly stand out from the floorplan by using a bolder line width contrasting a screened floorplan. Devices and notation are to be proportionally sized to the scale of the drawing. Fire alarm devices only are to be indicated on drawings, drawings are not to be shared with electrical devices or any other discipline.
- G. Documentation:
 - 1. Approval and Acceptance: Provide the Record of Completion form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
 - 2. Record of Completion Documents: Provide the Permanent Records according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
 - a. Electronic media shall be provided to Architect and authorities having jurisdiction.
1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project and shall be supervised by a Nicet Level III Supervisor.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. FACP and Equipment:
 - a. Proprietary systems are not allowed.
 - b. Siemens.
 - c. Silent night
 - d. Notifier.
 - e. Fire Lite.
 - f. EST.
 - g. SimplexGrinnell.
 - h. Faraday.
 - i. Honeywell

2.2 FACP

- A. General Description:
 - 1. Modular, power-limited design with electronic modules, UL 864 listed.
 - 2. Analog addressable control circuits for operation of mechanical equipment.
 - 3. System shall be sized for the number of points indicated plus (20) twenty percent spare.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: Liquid-crystal type, two line(s) of 40 characters, minimum.
 - 2. eypad: Arranged to permit entry and execution of programming, display, and control commands.
- C. Circuits:
 - 1. Signaling Line Circuits: NFPA 72, Class B, Style 4.
 - 2. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
 - 3. Circuits shall be configured with loop isolators.
 - 4. Actuation of alarm notification appliances, annunciation, elevator recall shall occur within 10 seconds after the activation of an initiating device.
 - 5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

- D. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.
- E. Elevator Controls: Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shuts down elevators associated with the location without time delay.
 - 1. A field-mounted relay actuated by the fire detector or the FACP closes the shunt trip circuit and operates building notification appliances and annunciator.
- F. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.
- G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.
 - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an alarm silence light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
 - 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- H. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.
- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.
 - Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory signal and supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
 - 1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the powersupply module rating.
 - 2. Power supply shall have a dedicated fused safety switch or circuit breaker for this connection at the service entrance equipment. The switch box or circuit breaker shall have red marking and identify it with FIRE ALARM SYSTEM POWER. Where a circuit breaker is the disconnecting means, an approved breaker locking device shall be installed.
 - 3. Provide surge protection on all 120 volt power serving fire alarm equipment.
 - Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
 - 1. Battery and Charger Capacity: Comply with NFPA 72.
 - 2. Provide surge protectors on all circuits.
- L. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays

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and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE ALARM PULL STATION

- A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
 - 2. Station Reset: ey- or wrench-operated switch.

2.4 SYSTEM SMO E DETECTORS

- A. General Description:
 - 1. UL 268 listed, operating at 24-V dc, nominal.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - 3. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
 - 4. Multi-criteria with minimum of thermal and photoelectric.
- B. Multi Criteria Detectors:
 - 1. Minimum of photoelectric and heat.
 - 2. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 3. Photoelectric Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
 - 4. Thermal detection.
- C. Photoelectric Smoke Detectors:
 - 1. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
- D. Duct Smoke Detectors:
 - 1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
 - 2. UL 268A listed, operating at 24-V dc, nominal.
 - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - 4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plugin module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
 - 5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

- 6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
- 7. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
- 8. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 HEAT DETECTORS

- A. General: UL 521 listed.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate-of-rise of temperature that exceeds 15 deg F (8 deg C) per minute, unless otherwise indicated.
 - 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
 - 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

- A. Description: Equipped for mounting as indicated and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.
- C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word FIRE is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 - 1. Rated Light Output: Candela indicated on drawings.
 - 2. Strobe Leads: Factory connected to screw terminals.
 - 3. Where multiple visual notification appliances can be seen from any location, circuitry shall be incorporated for the synchronization of flash rate.
 - 4. Adjustable Strobes-Field selectable from 15cd, 30cd, 75cd, 110cd.

2.7 SPRIN LER SYSTEM REMOTE INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 REMOTE ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Class 1.
- B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall and to a circuit-breaker shunt trip for power shutdown.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled according to UL 632.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated. The contractor shall provide conduit and cable to telephone backboard.
- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 CELLULAR COMMUNICATOR TRANSMITTER

- A. Napco Starlink Fire LTE Commercial or approved equal.
- B. UL Listed.
- C. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically communicates to the central station. When contact is made with the central station(s), the signal is transmitted.
- D. If needed remote antennas shall be installed to allow for communications to monitoring company.
- E. Communicator shall be compatible with the owner's monitoring company.
- F. Communicator shall be powered by the FACP.

G. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 NETWOR COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
- C. Provide integration gateway using BACnet and Modbus protocol for connection to building automation system.

2.13 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
 - 1. Twisted shielded pair, NFPA 70 Article 760, UL listed as Type FPLP, plenum rated and complying with requirements in UL 1424.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
- 2.14 Station Smoke and Carbon Monoxide Detectors:
 - 1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
 - 2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72
 - 3. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with low or missing battery chirping-sound device.
 - 4. Auxiliary Relays: One Form C, rated at 0.5 A.
 - 5. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
 - 6. Visible Notification Appliance: 177-cd strobe.
 - 7. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
 - 8. Test Switch: Push to test; simulates smoke at rated obscuration.
 - 9. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 - 10. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plugin module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 11. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - 12. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

- 13. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
- 14. Comply with UL 2075

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
- B. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.
- C. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- D. Audible Alarm-Indicating Devices: Install per NFPA 72. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- E. Visible Alarm-Indicating Devices: Install per NFPA 72.
- F. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- G. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.
- H. The contractor shall provide the following spare devices at a location determined by the engineer or fire marshal prior to final approval of shop drawings. Contractor shall be responsible for all conduit, wire, battery, cards etc. needed to install these spare devices. Devices not used shall be delivered to the owner as spare. Devices: 6 horn/strobes (any candela), 4 pull stations, 4 smoke detectors, and 4 control modules.

3.2 WIRING INSTALLATION

- A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
- B. Wiring Method:
 - 1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable. Cable installed in plenum ceiling spaces shall be plenum rated. Fire alarm cable installed in walls, exposed areas or in inaccessible spaces shall be in conduit. All cable and conduit shall be concealed where possible.
 - 2. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- G. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Basic Electrical Materials and Methods Electrical Identification.
- B. Install instructions frame in a location visible from the FACP.
- C. Paint power-supply disconnect switch red and label FIRE ALARM CIRCUIT CONTROL.

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
 - 2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters.
 - 3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
 - 4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
 - a. Detectors that are outside their marked sensitivity range shall be replaced.
 - 5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Provide a minimum of 2 hours of training to the Owner's Representative.

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